

# **Three Essays in Education Finance**

by

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## ABSTRACT

My dissertation consists of three chapters in the field of education finance. In the United States, education is the joint responsibility of Federal, state, and local governments. I explore the interactions between these different sources of funds and examine how these are affected by a variety of factors: immigration, policy changes, and education finance reform. I study state and local government education budgeting decisions, and build economic models that capture realities of public education financing when there are different but interrelated sources of funding. I use empirical analysis on extensive data on school district finances linked to demographics to evaluate the empirical implications of these models, and develop comprehensive measures of tax adjustments in public education finance.

My first chapter offers an alternative interpretation of the negative relationship between immigration flows and changes in per-pupil spending in U.S. school districts. I argue that fiscal channels are sufficient to explain the negative effect of immigration on education funding and decompose the effect into separate responses at different levels of government. Immigrants have lower incomes on average than natives, and so their immigration increases the cost to natives of providing uniform education. I find that while state contributions to education do not respond to immigration, local governments decrease education revenues by 7.4 percent for every 1 percentage point increase in immigration, or about \$319 when evaluated at the 2007 average county education contribution. This corresponds to an estimated elasticity of -0.43. Thus, median voter politics largely insulate state governments from increases in the tax price of education in the presence of immigration, but do not do so for local governments.

My second chapter estimates the impact of Federal grant expansions during the Great Recession. During this period, the Federal government increased its contributions toward K-12 education by about 50%. I use an instrumental variable approach to estimate the effect of these expanded Federal contributions on state and local district education finance, focusing on the extent of crowd-out. I find that the fiscal response to increased Federal funding is different at these two levels of government, and is dependent on the program through which the additional funds are channeled. Funds from expanded existing programs like Title I and IDEA Special Education did not crowd out state and local district education contributions. These grants increased total revenue dollar for dollar. In sharp contrast, funds from the new State Fiscal Stabilization Fund completely crowded out state education contributions, leaving local district contributions unaffected.

My third chapter investigates the crowding out of increased state education contributions on total education spending at the school district level and explores how the crowd-out rate relates to the states choice of education funding system. Using an event study framework, I find that different properties of education funding systems imply different



levels of redistribution within-state. State finance systems with properties that encourage equalization, like minimum foundation plans and spending limits, result in crowding-in of education funds by state contributions. On the other hand, properties like equalization plans and reward-for-effort plans result in crowding-out of funds.

## CHAPTER I

# Immigration, Fiscal Federalism, and the Tax Price of Education

### 1.1 Introduction

The U.S. has seen rapid growth in immigration since the Immigration and Naturalization Act of 1965 abolished immigration quotas, with the U.S. foreign-born population increasing four-fold (and share increasing three-fold) from 1970 to 2013 (Figure 1.1). A consequence of this growth is rising diversity in communities, which has been associated with declining support for public goods provision, particularly for public education. Much of the previous literature on this topic has focused on social mechanisms like ethnic fragmentation (Alesina et al. (1999), Dahlberg et al. (2012)), in-group biases (Coen-Pirani (2011), Speciale (2012)) or cultural differences (Baldwin and Huber (2010)), but much less studied is how changing fiscal burdens induced by immigration may be driving this phenomenon.

In this paper, I argue that fiscal channels are sufficient to explain the negative effect of immigration on education funding and decompose the effect into separate state and local government responses. I develop a model that explicitly describes how immigration changes the tax price of education, which is the amount of additional taxes that have to be paid by the taxpayer in order to raise public education by \$1. This change is not uniform in the separate jurisdictions, which allows me to provide a quantitative measure of how immigration impacts public education finance at different levels of government.

There are three major themes that emerge from this investigation. First, state and local governments do not respond equally to immigration. In the U.S., the responsibility<sup>1</sup> for education funding is almost equally shared between state and local governments, which face different tax bases and different incentives when setting taxes. Because money is

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<sup>1</sup>About 90% of all education revenues in 2014 are attributed to state and local governments. The remainder is attributed to Federal sources. Source: NCES Digest of Education Statistics.

fungible, past analyses using current spending in education as the outcome variable are unable to distinguish between these two responses. By focusing on education revenues instead of spending, I am able to find a better measure of how governments respond to immigration. Second, immigration into a district does not change the amount of per-pupil state aid that the district receives. This is because median voter politics implies that the choice of state contributions is made outside of the district, and that decision depends only on the relative magnitude of median district<sup>2</sup> income and mean state income. Third, immigrants tend to be poorer than natives (Figure 1.2), and so immigration into a district weakly increases the tax price of education which is the amount of taxes that has to be paid to raise the funding of public education by \$1. Because education is now more expensive, the district reduces its per-pupil education funding contribution.

I model education spending as the solution to a two-stage optimization problem, which reflects how education revenues are raised in the vast majority of states. At the state level<sup>3</sup>, legislators decide on a minimum level of per-student education funding, called the foundation grant. At the local district level, each of the districts in the state can choose to augment the foundation grant by collecting local taxes subject to rules specified by state legislation.

The model describes how state and local tax revenues change in response to changes in immigration. The interaction between state and local governments' funding decisions have implications for their ability to respond to immigration. Because there is a single state funding scheme, state legislators act to redistribute income within the state. The model predicts that state education revenues allocated towards a particular district are negatively related to district income, but are independent of the district's immigrant share. On the other hand, local districts set their own tax rates, and wealthier districts are less constrained by the state minimum education requirement than poorer districts. The model predicts that district education revenues are positively related to district income, and are negatively correlated to immigration. Combining this with the observation that immigration decreases total education revenue leads to the result that the effect of immigration is concentrated at the local district level.

My empirical analysis exploits variation at the county level using decennial data from 1990-2007 to show the long-run impact of changes in immigration on education finance. Concerns about reverse causality due to Tiebout (1956) sorting or omitted variable bias are addressed by using an instrumental variable that is the predicted change in the fraction of

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<sup>2</sup>The median district I refer to here is the median voter for the purposes of determining state contributions to education. Section 1.2 describes this in more detail.

<sup>3</sup>This describes how education funding works in most, but not all states. More details are provided in Section 1.2

foreign-born residents based on historical immigrant settlement patterns, as done in Card (2001) and Wozniak and Murray (2012). The empirical analysis supports the theoretical predictions of the model. I show that the previously downward decrease in education spending that is associated with an increase in immigration into a district is due almost entirely to a decrease in education revenue raised by the local school district. This can be attributed to a substitution effect: immigrants to a district increase the local tax price of education by more than the increase in the state tax price, and so raising funds for education becomes relatively more expensive at the local level.

The rest of this paper is organized as follows. Section 1.2 describes the prior literature and the institutional background of U.S. public K-12 education finance. Section 1.3 introduces the model set-up and describes the implications of the model. Section 1.4 describes the data used to test the model implications. Section 1.5 and 1.6 present the empirical framework and analysis. Section 1.7 concludes.

## **1.2 Background**

In this section, I describe the state of the literature on immigration and public education provision, and provide an introduction to the institutional background of public K-12 education that informs the model set-up.

### **1.2.1 Prior literature**

This paper is related to several strands of the literature on public goods. Specifically, it relates to the extensive work on population demographics as determinants of government spending on public goods. However, while this literature is extensive, in this paper I focus on immigration and explore the fiscal mechanism of its impact on public education finance. This paper is also unique in that it approaches this question from two perspectives, a theoretical, model-driven approach and an empirical approach.

The literature on demographics and public good provision shows that there are low levels of public good provision in heterogeneous and ethnically diverse societies. The seminal paper by Alesina et al. (1999) finds that individuals' willingness to contribute to public goods depends on the racial composition of the community. In particular, the authors' cross-sectional analysis shows that higher levels of racial fragmentation are associated with lower spending. There are several different mechanisms that have been proposed to explain this empirical result. Alesina and Ferrara (2005) describe in their review of the literature that perhaps different ethnic groups may differ in their preferences for public

goods, and so increased diversity results in an increased difficulty to agree on a common public policy or a common level of public good provision.

Hoxby (2001) finds that at the metropolitan statistical area (MSA) level, increased racial heterogeneity has a negative effect on education spending. La Ferrara and Mele (2006) subsequently showed that there is increased racial segregation at the level of school jurisdictions, implying that individuals are sorting within the MSA level into more racially homogeneous districts. They also find that racial segregation has a positive effect on average per-pupil spending on education, but there is more inequality across districts in the same MSA. A related paper is Urquiola (2005), which finds that as districts become more racially distinct within MSAs, there is increased diversity in the levels of per-pupil spending in these districts.

Changing demand for public good provision is also induced by the changing age distribution as the baby boom population ages. Policymakers have long focused on the impact of aging populations on Federally-funded programs like Social Security and Medicaid, but state and local governments also have cause for concern. The literature suggests that the elderly vote to support their own interests, and so as populations age, the shifting political power from the working-age to the elderly could potentially lead to fewer resources being allocated toward public goods targeted for children, including education. The most influential paper in this category is by Poterba (1998), who examined how intergenerational conflict has affected states' willingness to fund public education. He finds that a high proportion of people over 65 in a state is associated with a lower amount of state spending on public education. He also finds the negative relationship is more pronounced in the states where older individuals are ethnically or racially different from those that are school-aged. Ladd and Murray (2001) analyze the same relationship at the county level and find a much smaller elasticity, due to more stringent controls to account for Tiebout bias. The elderly tend to move to counties with fewer children, and so even if at the state level they have a negative effect on education spending (the Poterba result), the effect is diminished at the county level.

There is a growing literature on the relationship between immigration and public goods spending. Bheim and Mayr (2005) use a model where natives derive less utility from immigrants' use of public goods. Their empirical work uses data from OECD countries and find heterogeneous effects of high- vs low-skilled immigration. Specifically, while high-skilled immigration has a positive effect on public spending, the presence of anti-social effect means that low-skilled immigration has a negative effect on public spending.

In the United States, the education finance literature focuses primarily on the Mexican immigrant population or the traditional immigrant settlement states. Coen-Pirani (2011)

models education as a pure state public good and uses data from California to argue that a 19% decrease in education spending can be attributed to immigration. However, he does not account for the fact that in California a significant portion of spending is not determined at the state level, and so education spending is not completely equalized across the state. Furthermore, Mexican immigrants are a minority of all U.S. immigrants<sup>4</sup>, and so a more complete analysis of the impact of immigration should also include the foreign-born from countries other than Mexico.

Dottori et al. (2009) develop a theoretical model of how low-skilled immigration affects public education spending. The mechanism studied in their paper is the erosion of the tax base, coupled with an increased demand for private education and lower funding of public education. Similarly to the Coen-Pirani model, education is considered a state public good and local government responses are not considered in the authors' analysis. Their paper is solely theoretical and does not contain an empirical section. By bringing data from an extended time period into my analysis, I am able to estimate a measure of the impact of immigration.

Finally, the most closely related paper to my empirical work is that by Speciale (2012). He analyzes the impact of immigration on the EU-15 countries using the distance from the Balkan wars as an instrument and finds a small negative effect of immigration on public education expenditures, an elasticity of -0.15. Similarly to Poterba and Ladd and Murray, he also suggests that the channel driving this result is that ethnically diverse societies may be valuing public goods lower than private goods. In contrast, my analysis is set in the U.S. and takes advantage of the extensive data that has been collected on state districts and demographics over a large time period, and my elasticity estimates fall within the range of the elasticity estimates in these earlier papers.

### **1.2.2 State and local roles in K-12 public education finance**

In this subsection, I describe how states and local districts make the decision on how much public education funding to award to districts, and how that informs my theoretical model.

Education funding is a shared responsibility between Federal, state, and local governments, but most of the burden lies with state and local governments. The state and local government share is about 90% compared to the Federal government's 10%, and this division has been stable over time, with a slight inclination toward more state spending.

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<sup>4</sup>Mexican foreign-born people constitute about 28% of all foreign-born U.S. residents of 2014, and this number has been decreasing over time. Source: Migration Policy Institute's ACS/Census data tool accessed at <https://www.migrationpolicy.org/programs/data-hub/state-immigration-data-profiles>.

Figure 1.3 shows the trend of education revenue by source.

The largest programs through which the Federal government funds education are No Child Left Behind Title 1 Grants, which are directed toward school districts via funding formulas based on student characteristics such as child poverty rates. The second largest program are Individuals with Disabilities Education Act (IDEA) Special Education Grants, which are allocated to districts according to child statistics relating to disabilities. Nevertheless, education does not constitute a large fraction of the Federal government's budget, with only \$55.9 billion going K-12 education in 2013, approximately 1.4% of the total Federal budget that year. Furthermore, because most Federal education funding is tied to these formulas under current law, there is less scope for the Federal government to respond to immigration.

In contrast, K-12 education is the largest single element of state and local governments' spending, about \$620 billion in 2012-2013 (Figure 1), approximately 20% of their combined total annual budget. There is a large variation both within- and across states of the level of education spending (Figure 1.4, top panel). On one end of the distribution, Hawaii funds 100% at the state level, since it has only one statewide school district and no local districts. On the other hand, for most of the rest of the country, public education is a shared expense between these two levels of government. The extent of a school district's authority to set budgets and raise revenue primarily depends on which education finance system is used by the state where the school district is located. The decision on how to spend the money earmarked for education, once it is collected, is also dependent on the type of funding system in use. Figure 1.5 maps the states and the funding systems they use as of 2007.

States allocate K-12 education funds to their constituent districts through funding formulas, which are directly related to the school finance system. There are five primary categories of funding formulas currently in use, which may be used in combination by some states. These categories, in order of popularity, are the foundation system, the flat grant, local-effort equalization, equalization, and full state funding (Hightower et al. (2010)).<sup>5</sup>

The most common system of state funding, used by 38 states, is called the minimum foundation program (MFP). States under MFP guarantee a minimum spending level per student (also called foundation aid) and allow school districts to levy taxes to supplement this amount if the guaranteed level is found insufficient. The responsibility of determining the amount of foundation aid lies with state legislators and the state education agency,

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<sup>5</sup>The analysis in this paper focuses on the experience of districts in states that use MFP. However, the relationship between state contributions and local contributions depend highly on the properties of the state finance system. As a result, the causal estimates presented in this paper may be different for states that do not use MFP. This is explored further in Lucasan (2018).

which may also include limits to how much additional millage (taxes) that the local school board can levy.

Local education funding levels are set by school boards under the constraints specified by state legislation. Because different states choose different tax rates and may have different rules for the extent to which the districts can top up the state contribution, there is significant variation in the amount of public education revenues raised by local governments both across and within states. Furthermore, even within the state constraints, districts still have a lot of discretion on how much more additional taxes to raise for public education and as a result, there is also significant variation in local education revenues even within states (Figure 1.4, bottom panel).

The funding formula in use by each state can typically only be changed by a court case challenging the constitutionality of the current funding formula, or through legislation, both of which can be a difficult and drawn-out process.<sup>6</sup> As a result, the funding system used in a state is fairly consistent, and only in very few cases is it overturned more than once each decade.<sup>7</sup> Over time, the number of states using MFP has grown, and as a result, U.S. K-12 education finance is increasingly a top-down funding system: first states legislate the level of foundation aid, and second, the local government chooses a level of local funding in response. This dynamic decision-making process between state and local governments is the key characteristic in the model of education spending developed in this paper.

### **1.3 Determining per-pupil revenues at state and local levels**

In this section, I develop a model that describes how state and local governments modify their funding decisions in response to immigration. The basic set-up is based on the model of Fernandez and Rogerson (2003), modified to account for immigration. The primary features of the model are twofold: first, state and local governments make decisions sequentially, reflecting the top-down nature of funding decisions made in states using MFP. Second, I account explicitly for immigrants having less political power than natives in making the education funding decision at both levels of government.

The model assumes that the source of education revenues and the main avenue through

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<sup>6</sup>Legislative changes in the funding system are more voluntary, in that the state decides whether to undergo that change. Changes due to a court case are involuntary from the state's perspective. In the empirical work, as a robustness check I estimate all equations in a restricted sample only with states for which the last state finance reform was due to a court case. The results do not change with the restricted sample.

<sup>7</sup>For a list of court cases that have overturned the prevailing school finance system, see Jackson et al. (2015).



which governments respond to immigration is a proportional income tax. The tax rate decisions are made sequentially: first, states choose a state tax rate using the median voter theorem to aggregate the constituent districts' preferences, and once a statewide state tax rate is determined, districts choose local tax rates to supplement the state tax.

Let  $t_s$  and  $t_d$  be the state and local district income tax rates, respectively, and education is funded through these taxes. While this is certainly a departure from the reality of property taxes funding a significant proportion of education revenues, it is a common assumption in the public goods literature. One can also think of these tax rates as taxes on an aggregate of incomes and property values; that specification would also be consistent with the model in this paper. The outcome variable corresponds to education revenues by source of funding, which in this paper is the product of tax rates and income.

I assume that there is a continuum of agents of size 1 in each district, and that are two types of agents in this economy, natives and immigrants. In order to simplify the analysis, I characterize the districts according to the average income of the natives residing in the district  $y_i$ , and also by  $m_d$ , the fraction of the district population that is immigrant.

There are two goods in the economy, a consumption good  $c$  (private) and child education  $q$  (publically provided private good). I assume that education is funded by a proportional tax on income, and all children attend local school districts. While there is a significant amount of debate in the literature about how education spending is translated to education quality, I abstract from this issue and suppose that  $q$ , the amount of child education, depends only on the amount of spending per student.

In this model, because immigrants are assumed to not vote, the utility of the district only depends on the utility of native residents, and so the private good consists of the consumption of natives only. Thus, district utility is equivalent to average native utility in the district. Later in this paper, I discuss extensions of this model where this assumption is relaxed. Consider the following utility function for a district where the average native income is  $y_i$ , and has immigrant fraction  $m_d$ .

$$U = u(c_i) + v(q_i) \tag{1.1}$$

In (1.1),  $u$  and  $v$  are increasing in  $c$  and  $q$ , respectively, and are concave. The constraints are:

$$\begin{aligned} c_i &= (1 - t_s - t_d)y_i \\ q_i &= t_s \bar{y} + t_d y_d \end{aligned}$$

Private consumption,  $c_i = (1 - t_s - t_d)y_i$ , is whatever is left behind from income after

paying taxes. Child education is the lone public good, and the total amount spent on education is the sum of state and district tax revenues. The amount of educational funding raised by the state that is allocated to any individual is  $t_s \bar{y}$ , where  $\bar{y}$  is the mean income in the state. Similarly,  $t_d y_d$  is the amount of educational funding raised by the local district that is allocated to any individual, where  $y_d$  is the mean income in the district.

Both  $\bar{y}$  and  $y_d$  include immigrant income because immigrants contribute fully to the tax system and participate in public education. Mean district income can be expressed as

$$y_d = (1 - m_d)y_i + m_d y_m,$$

where  $y_i$  is mean native income,  $y_m$  is immigrant mean income, and the fraction of immigrants in district  $d$  is  $m_d$ . Similarly, mean state income is just the weighted average of native incomes and migrant incomes in the state.<sup>8</sup>

State legislators choose  $t_s$  that applies to all districts in the state. A positive state tax rate guarantees a minimum education spending level for these districts. The mechanism that states use to determine  $t_s$  is majority vote, which is characterized according to the median voter theorem. That is, the state legislators look at the preferred tax rates of all constituent districts and the median tax rate is chosen as the overall state tax rate. Because the districts decide on a local tax rate given the state's chosen a state tax rate, the districts are able to incorporate the state's choice in making a decision. To reflect the reality of how education funding is determined in the foundation system, I model the tax rate decisions as made at two stages: first, at the state level to determine the foundation tax rate, and second, at the local level to determine the district tax rate.

The outcome of this model will be a single  $t_s^*$ , and a value of  $t_d^*$  for each constituent district. I consider each of the two decision-making stages in turn.

### 1.3.1 Choosing the level of state education revenues

In this subsection, I describe the process through which a state tax rate is chosen in states with a minimum foundation tax.

The state legislator solicits preferred state tax rates from school districts, and implements the median of these tax rates to be the state tax rate, in accordance with the mean

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<sup>8</sup>Consider the following numerical example. Dexter School District, in southeast Michigan, has native individuals with mean income \$120 ( $y_i$ ), and immigrants with mean income \$90 ( $y_m$ ). Suppose that 1/3 ( $m_d$ ) of Dexter's population is immigrant, and so overall district income is \$100 ( $y_d$ ). If the current state tax rate is 20% ( $t_s$ ) and the district tax rate is 15% ( $t_d$ ), then Dexter's schools' budget will consist of \$20 from the state of Michigan and \$15 from its own residents. Furthermore, average native individual has private consumption is equal to \$78, and the district's utility is  $u(78) + v(35)$ .

voter theorem. Because the median voter's choice of state tax rate prevails at the state level, the median voter chooses state and local tax rates simultaneously. The median voter's objective function is

$$\max_{t_s \geq 0, t_d \geq 0} u((1 - t_s - t_d)y_i) + v(t_s \bar{y} + t_d y_d)$$

The first-order conditions of this maximization are:

$$\frac{\partial U}{\partial t_s} = -y_i u' + \bar{y} v' \leq 0 \quad (1.2)$$

$$\frac{\partial U}{\partial t_d} = -y_i u' + y_d v' \leq 0 \quad (1.3)$$

Only one of the FOCs can be satisfied at a time. Thus, unless the median district's income is the same as mean state income, its optimal choice will have at most one nonzero  $t_s^*$  and  $t_d^*$ . Intuitively, the first-order conditions can be rewritten as

$$\frac{v'}{u'} \leq \frac{y_i}{\bar{y}} \quad (1.4)$$

$$\frac{v'}{u'} \leq \frac{y_i}{y_d}. \quad (1.5)$$

In both equations, the expression on the left-hand side is the marginal rate of substitution between private consumption and education, which is the same expression in both of these equations. The expression on the right-hand side is the relative price of private consumption and education. A utility-maximizing district chooses the funding source that offers a lower relative price. This price is the tax price of education, and is defined to be the additional taxes paid by the district in order to raise spending on education by \$1. State-sourced funding has tax price

$$\frac{t_s y_i}{t_s \bar{y}} = \frac{y_i}{\bar{y}}$$

while local-sourced funding has tax price

$$\frac{t_d y_i}{t_d y_d} = \frac{y_i}{y_d}$$

Local funding is cheaper when  $\frac{y_i}{y_d} < \frac{y_i}{\bar{y}} \iff \bar{y} < y_d$ , and state funding is cheaper when  $y_d < \bar{y}$ . By relying solely on the foundation grant, poorer districts' education are effectively subsidized by richer districts, and the chosen state tax redistributes from rich to poor. On the other hand, rich districts would prefer no redistribution, as with positive tax

rates they are subsidizing poorer districts with their taxes.

Formally, if  $t_s^* > 0$ , then (1.2) implies that  $y_i u' = \bar{y} v'$ , and by (1.3),

$$\begin{aligned} -y_i u' + y_d v' \leq 0 &\iff -\bar{y} v' + y_d v' \leq 0 \\ &\iff y_d \leq \bar{y}. \end{aligned}$$

Similarly,  $t_d^* > 0 \iff \bar{y} \leq y_d$ . When the median district's income is above the mean state income, it prefers to finance education purely through district collections, but if the median district's income is below the mean state income, it prefers funding through state collections.

To characterize the median district, observe that for every district that chooses a positive  $t_s$ , the binding FOC is given by (1.2), and preferred tax rates satisfy

$$y_i u'((1 - t_s)y_i) = \bar{y} v'(t_s \bar{y}). \quad (1.6)$$

Assuming that each of the districts places one vote for their preferred state tax rate, the median voter theorem implies that the tax rate that is implemented is the tax rate preferred by the median district. As the rich districts always choose  $t_s = 0$ , the state tax rate will be positive as long as the distribution of district incomes within the state is such that the median income is below the mean income. Figure 1.6 shows the districts' state tax choices, and illustrates how the state tax is chosen from these options. The first panel shows how preferred state tax rates change with district income,  $y_d$ . All districts with  $y_d > \bar{y}$  prefer  $t_s = 0$ , and all districts with  $y_d < \bar{y}$  prefer  $t_s > 0$ . Because I make no additional assumptions regarding the utility functions or the distributions of incomes, preferred  $t_s$  and  $y_d$  have covariance 0.

The second panel arranges the districts by preferred state tax rate, and indicates the tax rate ultimately chosen at the state level. The median tax rate,  $t_s^*$ , is positive when the median of district incomes is lower than the mean of district incomes, and  $t_s^* = 0$  otherwise.

### The effect of immigration on the state's choice

Next, I consider what happens to districts' preferred state tax rates and the prevailing state tax rate in the presence of immigration.

First, observe that the median voter's preferred state tax rate is implicitly given by

$$y_{med}u'((1 - t_s)y_{med}) = \bar{y}v'(t_s\bar{y}) \iff \frac{y_{med}}{\bar{y}} = \frac{v'(t_s^*\bar{y})}{u'((1 - t_s^*)y_{med})}, \quad (1.7)$$

where  $y_{med}$  is the mean native income in the median district. This expression does not depend on the level of immigration into the median district, and so the prevailing state tax rate  $t_s^*$  is unchanged by immigration into the median district.

Next, consider immigration into districts that are not the median voting district. As long as immigrants have lower income than the district mean, poor districts remain poor when immigration goes up. Poor districts' choices of preferred state tax rates are do not depend on immigration, so that the distribution of preferred tax rates is unchanged. This implies that immigration into a poor district does not change the tax rate chosen at the state level.

On the other hand, immigration into rich districts (those for whom  $y_d > \bar{y}$ ) has differential effects on the district's preferred tax rate depending on whether immigration causes district income to fall below the threshold. Suppose that immigration is low enough so that rich districts continue to be rich after increased immigration. In that case these districts continue to prefer zero tax rates, and immigration into these districts does not affect the distribution of preferred tax rates, and the implemented state tax rate is unchanged. However, if a rich district (which by definition has  $y_d > \bar{y}$ ) receives so much immigration that its income falls below the mean state income, the districts's preferred state tax rate increases from  $t_s = 0$  to  $t_s > 0$ . This change increases the chosen state tax rate if the district's new preferred tax rate is higher than the old state tax rate. For small changes in immigration, however, the effect of immigration into districts that are not the median district is zero.

Formally, the relationship between per-pupil state education revenues,  $t_s^*\bar{y}$ , and immigration into a district,  $m_d$ , is given by

$$\frac{\partial(t_s^*\bar{y})}{\partial m_d} = 0, \quad (1.8)$$

Similarly, the relationship between the change in per-pupil state education revenues and the change in immigration into a district is given by

$$\frac{\partial(\Delta t_s^*\bar{y})}{\partial \Delta m_d} = 0. \quad (1.9)$$

A major assumption in this discussion is that all districts are considered equally by the

state legislator without any consideration to district size – one district, one vote. This means that if this assumption is relaxed to allow larger districts to have more votes, if wealthier districts are larger, then the median preferred state tax rate will be lower than that predicted by the model. This is because all the wealthy districts vote for no state tax education funding, and so any estimate derived under the assumptions of this model will be a lower bound on the true impact of immigration.

### 1.3.2 Choosing the level of district (local) education revenues

In this subsection, I move to characterizing the local tax rates chosen at the district level, once a state tax rate has been selected.

Local districts choose local tax rates to maximize utility within the district. Consider the case when the prevailing state tax rate is positive, which occurs when the median district has income less than the mean income in the state. The district solves the following problem:

$$\max_{t_d \geq 0} u((1 - t_s^* - t_d)y_i) + v(t_s^*\bar{y} + t_dy_d) \quad (1.10)$$

Districts are allowed to increase their education spending above the foundation grant through additional taxes on district income, but are not allowed to go below the foundation grant, so  $t_d$  cannot be negative. When districts opt not to top up the foundation grant, per-pupil total education spending in the district is  $t_s^*\bar{y}$  per student. Hence the positive state tax rate guarantees a minimum education spending level for districts within the state.

The first-order condition is  $-y_i u'((1 - t_s^* - t_d)y_i) + y_d v'(t_s^*\bar{y} + t_dy_d) \leq 0$ . Some districts are constrained by the state foundation grant to choose  $t_d = 0$ . These are districts that would prefer less education, but are required by the state to provide at least  $t_s^*\bar{y}$ . The constrained districts are those for which

$$-y_i u'((1 - t_s^*)y_i) + y_d v'(t_s^*\bar{y}) < 0 \iff \frac{y_d}{y_i} < \frac{u'((1 - t_s^*)y_i)}{v'(t_s^*\bar{y})}. \quad (1.11)$$

On the other hand, some districts will opt to top up the foundation grant, by selecting a positive  $t_d^*$ . These districts face the following first-order condition:

$$-y_i u'((1 - t_s^* - t_d)y_i) + y_d v'(t_s^*\bar{y} + t_dy_d) = 0 \iff \frac{y_d}{y_i} = \frac{u'((1 - t_s^* - t_d)y_i)}{v'(t_s^*\bar{y} + t_dy_d)}. \quad (1.12)$$

## The effect of immigration on the districts' choice

Now I turn my attention to how the districts' choice of local tax rates is affected by changes in immigration.

In the first-order conditions (1.11) and (1.12) that determine optimal district tax rates, immigration only appears in  $y_d$ . Hence, the effect of immigration on a district's choice of tax rate can be characterized based only on how  $m_d$  impacts  $y_d$ . When immigrants are poorer than natives, more immigration results in a decrease of  $y_d$ . If  $y'_d$  is district income after an influx of immigrants,

$$\frac{y'_d}{y_i} < \frac{y_d}{y_i} < \frac{u'((1 - t_s^*)y_i)}{v'(t_s^*\bar{y})}. \quad (1.13)$$

That is, constrained districts, that choose  $t_d = 0$ , continue to be constrained when immigration increases. All constrained districts choose  $t_d = 0$ , and so for these districts  $t_d^*$  is unaffected by an increase in immigration.

For districts that are unconstrained, I can apply the implicit function theorem on the first-order condition. Hence, the effect of immigration on the district tax rate is

$$\frac{\partial t_d}{\partial m_d} = -\frac{(y_m - y_i)[v' + t_d y_d v'']}{y_i^2 u'' + y_d^2 v''}. \quad (1.14)$$

The sign of the relationship between the fraction of immigrants and district tax rates is the same as the sign of  $(y_m - y_i)[v' + t_d y_d v''] = (y_m - y_i)[v'(q) + qv''(q)]$ . The expression  $v'(q) + qv''(q)$  is positive as long as the slopes of  $v$ 's indifference curves in  $(t_d, q)$  are increasing in  $y_d$  (I will refer to this property as ISI, for increasing slopes in income, henceforth). As a proof, observe that the slope of  $v$ 's indifference curves are  $-\frac{y_d}{v'}$ . Taking the derivative of the slope as  $y_d$  changes gives the following expression:

$$\frac{\partial \text{slope}}{\partial y_d} = \frac{v'[v' + t_d y_d v'']}{v'^2} = \frac{v' + t_d y_d v''}{v'} \quad (1.15)$$

Because  $v$  is increasing, when the slope is increasing in district income, it must be that  $v' + t_d y_d v'' > 0$ .

Therefore the sign of  $\frac{\partial t_d}{\partial m_d}$  only depends on the sign of  $y_m - y_i$ . This implies that if immigrants are poorer than natives, then an influx of immigrants lowers the district's optimal  $t_d$ , and if immigrants are wealthier than natives, then immigration increases optimal  $t_d$ .<sup>9</sup>

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<sup>9</sup>Consider the special case where the median district income in the state is higher than mean state income, and the median district's preferred  $t_s^*$  is 0. This is a purely locally-financed education system, and total

Finally, I can characterize the effect of immigration on district education revenue,  $t_d y_d$ , as

$$\begin{aligned}\frac{\partial(t_d y_d)}{\partial m_d} &= y_d \left( \frac{\partial t_d}{\partial m_d} \right) + t_d \left( \frac{\partial y_d}{\partial m_d} \right) \\ &= y_d \left( \frac{\partial t_d}{\partial m_d} \right) + (y_m - y_i) t_d \\ &= (y_m - y_i) \left[ -\frac{(y_d)[v' + t_d y_d v'']}{y_i^2 u'' + y_d^2 v''} + t_d \right]\end{aligned}$$

Again, the term in the square brackets is positive if  $v$  satisfies ISI. This implies that if, on average, immigrants earn less than natives in the district ( $y_m - y_i < 0$ ), then more immigration leads to both a lower  $t_d$  and also lower education spending at the district level. On the other hand, if immigrants earn more than natives in the district ( $y_m - y_i > 0$ ), then more immigration leads to higher education spending.

Unlike the state case, the distribution of immigrants within the state matters in the determination of  $t_d^*$ . The response of local districts to immigration depends on how immigration affects overall district income. When immigrants are poorer than the district residents, then immigration will decrease  $t_d^*$ . Those districts that are already spending the minimum amount on education are unable to decrease education spending further, so will not change their fiscal behavior. On the other hand, when immigrants are wealthier than the district residents, an influx of immigrants increases  $t_d^*$ .

Intuitively, the previous results is because at the local level, the tax price of public education is

$$\frac{t_d y_i}{t_d y_d} = \frac{y_i}{y_d} = \frac{y_i}{y_i + m_d(y_m - y_i)}. \quad (1.16)$$

Hence when immigrants are relatively poor, or  $y_m - y_i < 0$ , increased immigration increases education spending will only depend on local district tax rates. The district problem reduces to

$$\max_{t_d \geq 0} u((1 - t_d)y_i) + v(t_d y_d).$$

The first-order condition is  $-y_i u'((1 - t_d)y_i) + y_d v'(t_d y_d) \leq 0$ . An optimal district tax rate exists for all districts because preferences are single peaked, and this optimal tax rate is feasible since there are no additional constraints. Applying IFT,

$$\begin{aligned}\frac{\partial t_d}{\partial m_d} &= -\frac{\frac{\partial y_d}{\partial m_d} [v' + t_d y_d v'']}{y_i^2 u'' + y_d^2 v''} \\ &= -\frac{(y_m - y_i)[v' + t_d y_d v'']}{y_i^2 u'' + y_d^2 v''}\end{aligned}$$

This is the same first-order condition as in the  $t_s^* > 0$  case. Therefore as long as  $v$  satisfies ISI, the same model implications hold for  $t_s^* = 0$ .



the tax price of education at the district level, as the immigrants provide a smaller fraction of tax revenues while consuming an equal amount of education. Similarly, when immigrants are relatively wealthy, more immigration decreases the tax price of education for natives at the district level, as the new immigrants provide more taxes relative to increased education costs. However, this mechanism works only at the district level.

### 1.3.3 Summary of model predictions

In the previous subsection, I developed a model of education finance that allows me to make predictions on how immigration influences the amount of money raised to finance public education.

The first implication of the model is that per-pupil state education revenues are independent of immigration after controlling for average income within a state. This is because for the median district, an additional dollar of education spending costs  $y_i/\bar{y}$ . As long as native income in the median district is less than the state average income, the state tax rate will be positive. Furthermore, immigration only affects the tax price of education for the median district through its effect on state mean income. Hence, I have the following empirical prediction: within a state, state education contributions allocated to a particular district is independent of immigration into said district

The second implication of the model is that at the district level, per-pupil district revenues are affected by immigration through the district mean tax rates. When deciding to raise education revenues locally, an additional dollar of education spending costs  $y_i/y_d$ . When immigrants are relatively poor, more immigration decreases  $y_d$  relative to  $y_i$ , and the tax price of education spending is higher in those districts. This leads to less education spending in districts with more immigration. For an illustrative example, consider two districts where one has more immigrants than the other. Under the assumption that immigrants are the same everywhere, in order for these districts to have the same average income, it must be that district with the higher percentage of immigrants also has wealthier natives.<sup>10</sup> Then the tax price of education,  $y_i/y_d$ , is higher in the district with more immigrants. If these districts get the same change in immigrant share, if the district with wealthier natives will end up with lower district income, and the tax price of education will

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<sup>10</sup>To see that this is true, note that since the average district incomes are the same,

$$\begin{aligned} y_d = y_{d'} &\iff (1 - m_d)y_i + m_dy_m = (1 - m_{d'})y_{i'} + m_{d'}y_m \\ (1 + m_{d'})(y_i - y_{i'}) &= (m_d - m_{d'})(y_i - y_m). \end{aligned}$$

Because immigrants have on average lower incomes than natives, the term on the right-hand side has the same sign as  $(m_d - m_{d'})$ . Therefore, when a district has more immigrants,  $m_d > m_{d'}$ , then it must also have higher native income,  $(y_i > y_{i'})$  so that the two districts have the same average income.

further increase. The model predicts that the district with wealthier natives will choose to spend less on education in response to immigration.

Finally, in any school district, total education spending is  $t_s^* \bar{y} + t_d^* y_d$ . The impact of immigration on total tax revenues should broadly follow the direction of the impact on the district tax rates, but should be smaller in percentage terms due to the district response being diluted by the inaction of the state government.

A summary of model predictions is available in Table 1.1. In succeeding sections, I test this set of predictions on U.S. data. I will first describe the data that I use and the empirical equations, followed by an analysis of the main results.

## 1.4 Data

I test the implications of the model presented in the previous slide by applying it to a unique panel dataset covering the period 1970-2007. The primary data sources are the National Center for Education Statistics Local Education Agency Financial Surveys (F-33) for school district spending data and tabulations from the decennial Censuses for demographic data. For non-decennial years, I use the American Community Survey 2005-2007 3-year estimates. The NCES data collects data from the population of school districts only in years that end in 2 or 7. Hence the 1970, 1980, 1990, and 2000 SD financial data are from the surveys collected in 1972, 1982, 1992, and 2002 respectively. The 2007 financial data is from the 2007 wave of the NCES survey.

School district boundaries can change year to year, and in constructing a panel covering a long time period, it is very important to keep the school districts consistently defined over time. In order to do so, I use the 1969-1970 Geographic Reference File to assign contemporary school districts to the county they would have belonged to in 1970, resulting in a panel of observations at the county level. In cases where a school district belonged to more than one county, I assign its data to the parent counties according to population weight. For example, if the Ann Arbor school district had 80% of its population in Washtenaw county and 20% in Wayne county in 1970, then in subsequent years, I will always assign Ann Arbor's information to Washtenaw and Wayne counties in those proportions.

Constructing the panel at the county level has other advantages. First, counties are consistently defined over a long period of time, certainly longer than school districts. Second, school districts vary in the grades of schooling they offer, and some grade levels are more expensive to offer than others. By aggregating up to the level of the county, these concerns are minimized. This approach also ensures that the two-year gap between the financial data collection and the decennial Census does not cause inconsistencies, since all

the data is transformed into its equivalent 1970 county.

School districts can be broadly categorized as fiscally dependent or independent. Dependent school districts are those with no responsibility for fiscal decisions. Another government entity, often the local state, city, county, or municipal government, will approve the budget and set appropriate tax rates to support these budgets in dependent school districts. The vast majority of school districts, however, are fiscally independent, where the local school boards have the authority to develop a district budget and set tax rates in order to support their chosen budgets. The analysis is limited to independent school districts, which are able to select their own budgets and set tax rates without going through an external government entity.

In Hawaii, Maryland, North Carolina, and the District of Columbia, there are no independent school districts. Hawaii and the District of Columbia both have just one school district. Maryland and North Carolina both only have school districts that are run at the county level. The remaining states generally have a combination of both dependent and independent school districts.

My analysis also only includes states that use the minimum foundation system (as well as states that use MFP in combination with another financial system), as the theoretical model assumes a two-stage state and local decision that only occurs under MFP. While increasing numbers of states use MFP, not all of them consistently use MFP throughout the sample period. For some states, Supreme Court cases have reformed the existing state finance system, and the primary state education finance system may change in between time periods. I include a state  $\times$  year observation in my sample as long as at the time the financial data was collected, the state was under an MFP system. The data on court cases is derived from Jackson, Johnson, and Persico [2014]. The full sample consists of 7,251 county-year observations between 1970 and 2007.

## 1.5 Empirical framework

In this section, I describe the equations I use to estimate the impact of immigration on education spending, and analyze the findings at both state and local levels. The goal here is to disentangle the separate responses of state and local governments to changing tax prices induced by immigration. First, note that the model implications described in the previous section are based on three parameters: the fraction of immigrant population,  $m_d$ ; average district income,  $y_d$ ; and, for the district-level analysis, prevailing state tax rates  $t_s^*$ .

The general form of the estimation equation is

$$\ln Y_{c,t} = \beta_0 + \beta_1 Imm_{c,t} + \beta_2 Inc_{c,t} + X'_{c,t} \delta + \lambda_{state} + \gamma_t + \epsilon_{c,t} \quad (1.17)$$

where the outcome variable,  $\ln Y_{c,t}$ , is the logarithm of one of several fiscal per-student variables in local county  $c$ . In the first set of results,  $\ln Y_{c,t}$  is the log of current spending per student. This variable excludes not just capital outlays and current outlays but also transfers to private schools and charter schools, and is most comparable to existing analyses that only look at current spending. In the next set of results,  $\ln Y_{c,t}$  is the log of state education revenues per pupil and local education revenues per pupil. The primary explanatory variable,  $Imm_{c,t}$ , is the proportion of foreign-born residents in local county  $c$  at time  $t$ . I control for a set of various time-varying county characteristics, including a proxy for education demand, the relative size of elderly and school-age populations, and log median income within the county. I also include state- and time- fixed effects. I cluster the standard errors at the county level.

Because the local county's decision depends on the amount of state education contributions, the estimation equation for local revenue estimation is

$$\ln Y_{c,t} = \beta_0 + \beta_1 Imm_{c,t} + \beta_2 Inc_{c,t} + \beta_3 StateRev_{c,t} + X'_{c,t} \delta + \lambda_{state} + \gamma_t + \epsilon_{c,t} \quad (1.18)$$

where  $StateRev_{c,t}$  is the amount of state contributions to public education in the county.

### 1.5.1 First-differenced estimates

Using changes in the fraction of foreign-born as an explanatory variable provides several advantages over using levels of the fraction foreign-born. First, I am able to eliminate bias due to time-invariant characteristics. Second, to the extent that immigration patterns have changed over time, I am able to utilize increased variation in the immigrants' location decisions across time to estimate  $\beta_1$ . In particular, consider that the state with the largest increase in the share of population that is foreign-born is different in 1970 than it is in 2007.

I focus on long differences for two reasons: First, the one-year change in the fraction of foreign-born population, my primary explanatory variable, is very small and exhibits considerable noise. In addition, I am concerned about mean reversion in the fraction of foreign-born population<sup>11</sup>. Looking at a longer difference allows a more accurate measure

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<sup>11</sup>To think about mean reversion in the context of the foreign-born population, consider the following example. Suppose that the number of immigrants entering Washtenaw county follows a fixed distribution. In year  $t - 1$ , Washtenaw receives more immigrants than average. Since the distribution of immigrants is

of the changes in foreign-born population. I perform my analysis using the decennial years 1970, 1980, 1990, 2000, and 2007<sup>12</sup>.

I estimate the first-differenced equation version of (1.17),

$$\Delta \ln Y_{c,t} = \beta_1 \Delta Imm_{c,t} + \beta_2 \Delta Inc_{c,t} + \Delta X'_{c,t} \delta + \gamma_t + \varepsilon_{c,t} \quad (1.19)$$

When  $Y_{c,t}$  is state revenues per pupil,  $\beta_1$  corresponds to a linear approximation of  $\frac{\partial t_s^* \bar{y}}{\partial m_d}$ .

When  $Y_{c,t}$  is local revenues per pupil, the estimation equation is the first-differenced version of (1.3),

$$\Delta \ln Y_{c,t} = \beta_1 \Delta Imm_{c,t} + \beta_2 \Delta Inc_{c,t} + \beta_3 \Delta StateRev_{c,t} + \Delta X'_{c,t} \delta + \gamma_t + \varepsilon_{c,t} \quad (1.20)$$

The coefficient  $\beta_1$  corresponds to a linear approximation of  $\frac{\partial t_d^* y_d}{\partial m_d}$ .

### 1.5.2 IV estimation

A limitation of OLS or first-differences models when analyzing the impact of immigration on education spending is the possibility that the endogeneity of migrants' location decisions may lead to biased estimates. As suggested by Tiebout (1956), and several subsequent papers (Goldstein and Pauly (1981), Rubinfeld et al. (1987), among others), families may sort into counties according to their preferred level of public good spending, and this residential sorting would distort the causal effect of immigration on education revenues. In particular, because public education benefits accrue primarily towards younger households and households with children, counties that spend more on public education may attract more immigrants. We might see that immigrants, who skew younger and may have children that directly benefit from public education, select into areas with high education spending. Alternatively, immigrants may prefer to move to areas with good labor market conditions, or to areas that are more immigrant-friendly. The potential endogeneity of immigrant location decisions is corroborated by Figure 1.7, which shows that the wealthiest counties have the fastest growing immigrant populations. To the extent that wealth is a proxy for the good labor market conditions that attract immigration, one may observe that counties with more immigration also spend more on education, but this could

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constant, implies that in year  $t$ , Washtenaw is more likely to receive fewer immigrants compared to the previous year. Mean reversion implies that  $\Delta Imm_{c,t} = Imm_{c,t} - Imm_{c,t-1}$  is lower, and leads to positive bias in the  $\beta_1$  estimate.

<sup>12</sup>I use 2007 instead of 2010 to avoid confounding effects due to the Great Recession. As for the possibility that the Great Recession may have impacted education finance prior to 2007, I present robustness checks of all my estimates excluding 2007 from the analysis in a later section.

just be the result of selection bias and not a truly causal effect.

An instrumental variable strategy is required to eliminate the bias caused by endogeneity and consistently estimate the effect of immigration of education spending. My preferred instrument uses historical migration patterns to predict where new immigrants choose to locate, similar to approaches taken in the immigration literature (Card (2001), Wozniak and Murray (2012)). New immigrants tend to be concentrated geographically and come to the same areas where earlier immigrants from the same source country have chosen to reside (Bartel (1989)). That is, I employ an instrumental variable technique that uses historical immigration settlement patterns to predict current migration patterns. This instrument is particularly attractive because I avoid the possibility of endogenous sorting among immigrants. It stands to reason that 1970 immigrant settlement patterns will not affect contemporaneous choices of education spending outside of its impact on current migration. To be precise, I construct the following:

$$\hat{M}_{c,t} = \frac{N_{c,1970}}{N_{s,1970}} M_{c,t} \quad (1.21)$$

$$IV = \frac{N_{c,t-1} + \hat{M}_{c,t}}{T_{c,t-1} + \hat{M}_{c,t}} - \frac{N_{c,t-1}}{T_{c,t-1}} \quad (1.22)$$

In (1.21),  $M_{s,t}$  is the number of people residing in state  $s$  whose reported year of entry into the U.S. is between  $t - 1$  and  $t$ . The variable  $N_{c,1970}$  is the number of foreign-born residents that live in county  $c$  in 1970, while  $N_{s,1970}$  is the number of foreign-born residents in the entire state  $s$  in 1970. Hence  $\frac{N_{c,1970}}{N_{s,1970}}$  is the fraction of all foreign-born in the state that lived in the county. The variable  $\hat{M}_{c,t}$  is an approximation of how many of the new foreign-born that moved into the state moved into  $c$ .

Next, in (1.22),  $T_{c,t-1}$  is the total number of residents of county  $c$  at time  $t - 1$ , so that  $\frac{N_{c,t-1}}{T_{c,t-1}}$  is the actual fraction of county  $c$ 's population that was foreign-born at time  $t - 1$ . The term  $\frac{N_{c,t-1} + \hat{M}_{c,t}}{T_{c,t-1} + \hat{M}_{c,t}}$  is an approximation of the fraction foreign-born in  $t$ . The instrument, denoted  $IV$ , is an approximation of the change in the fraction of foreign-born population between  $t - 1$  and  $t$ .<sup>13</sup>

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<sup>13</sup>Consider the following numerical example. In 1970, Washtenaw had 10 foreign-born residents, out of the Michigan total of 100. Thus  $N_{c,1970} = 10$  and  $N_{s,1970} = 100$ . If Michigan received 2000 new immigrants between 1990 and 2000, then the approximate number of new immigrants coming to Washtenaw is  $(10/100)(2000) = 200$ . If in 1990 Washtenaw had 500 foreign-born residents and 1000 native-born residents,

## 1.6 Results and Analysis

In this section, I present the result from the estimation framework described in the previous section. I first analyze this data set graphically to observe if the patterns in levels data are consistent with the model presented in the previous section. I then test whether the instrumental variable I use is credible by checking that the identification assumptions are satisfied. Then, I move on to formal analysis of the estimation findings.

### 1.6.1 Graphical analysis

I explore whether the predicted pattern between mean income and total spending is apparent in the data even without controlling for any covariates. I categorize counties into deciles according to their mean income. In Figure 1.8, I graph local, state, and total education revenues against these deciles. What is apparent is that per-pupil state revenues are decreasing income, and per-pupil local revenues are increasing with median income. As local revenues increase more than the decrease in state revenues, overall education revenue increases with income. The graph also shows that over the panel time period, state contributions are higher than county contributions in relatively poorer counties, and only for the top 2-3 deciles is the county contribution higher than state contributions.

Finally, I look at the relationship between state revenues and local revenues. Similarly to the previous graph, I sort counties into deciles according to per-pupil state contributions to education. I then graph how county revenues and total revenues<sup>14</sup> evolve across these deciles. Table 1.9 shows that as per-pupil state revenues increase, county contributions fall before leveling off. This is consistent with the model prediction on county tax revenue: the higher state taxes are, the more counties are constrained to choosing not to top up the foundation grant. Hence, for high state contributions the county contributions level off and become flat. Furthermore, at low levels of state contributions, average local revenues are higher because fewer counties are constrained. Finally, total spending is U-shaped relative to state revenues, so that the counties that receive the lowest and highest amounts of state aid have relatively high total education revenues per pupil.

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the instrument will be equal to

$$IV = \frac{N_{c,t-1} + \hat{M}_{c,t}}{T_{c,t-1} + \hat{M}_{c,t}} - \frac{N_{c,t-1}}{T_{c,t-1}} = \frac{500 + 200}{1500 + 200} - \frac{500}{1500} = 0.078.$$

<sup>14</sup>Total revenues is the sum of Federal, state, and local education revenues per pupil.

### 1.6.2 Testing the credibility of the instrumental variable approach

The identification strategy requires two assumptions: that the instrument is correlated with actual changes in the fraction of foreign-born population, and that it is uncorrelated with the other factors that affect per-pupil state and local education revenues.

I provide evidence for these assumptions. Table 1.4 contains an estimate of the first-stage relationship between the instrument and the change in fraction of foreign-born population in each state for the baseline specification for estimating state revenues. It also contains the first-stage estimate where  $\Delta StateRev_{c,t}$  is added as a regressor, which is the specification used to estimate the local revenue equation. The F-statistics in both specifications are similar, 25.96 and 25.81 respectively<sup>15</sup>. This indicates a strong first-stage relationship and is evidence that the first assumption is satisfied.

Next, I investigate support for the exogeneity assumption required for IV estimation. Table 1.5 has estimates of the relationship between the pre-existing trend in per-pupil state and local revenues from 1965 -1970<sup>16</sup> and the instrument. If the instrument is able to predict the pre-existing trend, then the instrument is very likely to fail the exogeneity assumption. I find that the coefficient estimate of this relationship is not statistically significant. To address concerns about the extent to which this finding may be due to confounding effects of traditional immigrant settlement states, I rerun these regressions while excluding Texas and California. I find that excluding Texas and California reduces the coefficient estimate of the effect of immigration on this pre-existing trend. However, I find no significant impact. Thus, these tests indicate that the instrument is not driven by these immigrant states.

### 1.6.3 Estimation results

I now turn to analysis of the estimation results. The OLS levels estimates do not follow the same pattern described in the model. Instead, it shows that state education revenues are lower and local education revenues are higher in counties that experience the most immigration (Tables 1.2 and 1.3, respectively). However, in Figures 1.10, 1.11, and 1.12, I construct scatterplots of state-level changes in immigration over the time period 1970-2000 and the corresponding change in per-pupil fiscal variables. Figure 1.10 shows the correlation between the change in the fraction of foreign-born population and the change in per-pupil current spending between 1970 to 2007. I construct state-level observations

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<sup>15</sup>The similarity of these F-statistics is as expected. The only difference in these first-stage regressions is the addition of a single covariate,  $\Delta StateRev_{c,t}$ .

<sup>16</sup>Due to the timing of the Local Finance Surveys, this variable is actually the change in per-pupil revenues between the 1967 and 1972 waves of the survey.



by taking the mean of these variables across all counties in each state, weighted by the county population in 2007. I then draw a scatterplot of these variables. I observe that states that have higher increases in the fraction of foreign-born population have lower increases in per-pupil current spending. Figure 1.11 is similar to Figure 1.10, but with shorter 10-year differences, to illustrate that this negative relationship is also visible with shorter time horizons. Figure 1.11 contains the corresponding scatterplots for the changes between the following years: 2000-2007 (Panel a.), 1990-2000 (Panel b.), 1980-1990 (Panel c.), and 1970-1980 (Panel d.). I observe that the negative correlation observed with current spending between 1970-2007 is also apparent when looking at these shorter ten-year differences. These general trends mirror the predictions of the model presented in the previous section. Figure 1.12 shows the correlation between changes in the fraction of foreign-born population and per-pupil state revenue (Panel a.) and per-pupil local (county) revenue (Panel b.). The same pattern is evident: States with higher increases in the fraction of foreign-born population have lower increases in both per-pupil state revenues and per-pupil local revenues.

These estimates and scatterplots suggest that per-pupil current spending and per-pupil local revenues rose less in states that saw the largest growth in the fraction of immigrants. This also suggests that the correct estimation strategy should focus on changes, not levels. In other words, running first-differenced regressions will give a more accurate estimate of how education responds to immigration.

Tables 1.6 and 1.7 present the first-difference OLS and 2SLS estimates of the effect of a rising fraction of foreign-born population on state-sourced and locally-sourced K-12 education revenues. The first coefficient estimate presented corresponds to  $\beta_1$ , the coefficient on the primary explanatory variable, which is the change in the fraction-foreign born residing in the county. The second coefficient estimate presented,  $\beta_2$ , is the coefficient on changes in median family income. Standard errors, which are presented below the coefficient estimates in parentheses, are clustered at the county level.

The first four columns of Table 1.6 present the first-differenced OLS results for the state revenue equation. I find that per-pupil state education revenues are negatively associated with education spending. Furthermore, accounting for county-level controls on the age distribution and demand for education does not eliminate this association. However, the magnitude of the estimate decreases as I add more regressors, which indicates a potential relationship between the change in fraction-foreign born and county characteristics.

The remaining columns of Table 1.6 contain the instrumental variable results. The IV estimates are not significant, which are in line with the model predictions presented earlier. In column (6), I control for the change in the fraction of college-educated residents,

which is a proxy for the county's preference for education. Adding this regressor decreases the magnitude of the IV estimate, but the estimate on fraction college-educated is not statistically significant. In column (6), I add controls for the age distribution of residents in the county. The coefficient on the fraction of population that is under age 18 is significant and negative, but this is likely due to the high correlation between this variable and the number of students enrolled in the county, and is just a mechanical relationship. The coefficient for the fraction of population that is above age 65 is negative, consistent with the elderly voting in their own self-interest (Ladd and Murray (2001)), but the estimate is not statistically significant.

The coefficient for median income is negative and statistically significant for the first three IV specifications (Columns (5), (6), and (7)), which is consistent with the predictions of the model. However, controlling for the poverty rate (Column (8)) causes the coefficient on median income to become insignificant. This indicates that counties with more poverty receive higher state contributions to education. This indicates that poverty rates and median income perform similar roles for determining state contributions to education within a county.

Although they are insignificant, the IV estimates for the effect of a change in the fraction foreign-born population are more negative compared to the equivalent OLS estimates. This is as predicted – the OLS estimates do not account for the fact that immigrants may sort into counties according to factors like labor market conditions that also impact the level of state education revenues received by the county. To the extent that these labor market conditions are also favorable for state education contributions, I would expect that the OLS estimates are going to be more positive compared to the IV estimates for the state revenue estimation.

Table 1.7 presents the first-differenced OLS and IV results for the per-pupil local education revenues estimation. In contrast to the state-level estimates, all reported county characteristics are estimated to be statistically significant. As median voter politics implies that local county characteristics are less important for determining state contributions to education than for county contributions, this result is as expected.

The OLS results show a negative and significant relationship between the fraction foreign-born variable and local revenues. Similar to the state case, this is consistent with the observation that immigrants move to the wealthiest counties, to the extent that wealth is correlated with good labor market conditions or higher property values that on their own would raise local tax revenues. The endogeneity of the fraction foreign-born variable indicates that the OLS estimates will bias the results of a regression as a measure, and underestimate the negative causal impact of immigration on education revenues.

The IV estimates for the causal impact of the change in the fraction foreign-born on local education revenues are negative and statistically significant. I find that a 1% increase in the fraction foreign-born residing in a county causes a decrease in local education revenues raised by the county by 7.4%. This corresponds to a decrease of approximately \$319 per pupil when evaluated at the 2007 average county revenue level. This is also equivalent to an elasticity of -0.43 when evaluated at the 2007 mean fraction foreign-born.

The coefficients on the other covariates are also mostly significant, and the signs of which are consistent with the predictions of the model. Across all specifications, higher state contributions to education are associated with lower local contributions. In my preferred specification, the estimated elasticity is -.16, which implies that a 10% increase in per-pupil state contributions to education is associated with a 1.6% decline in per-pupil local education effort. Hence state contributions crowd out local funding for education.

Higher median district incomes are also positive and statistically significant. Adding a proxy for the county's preference for education (Column (6)) increases the magnitude of coefficient on the fraction foreign-born population, but this effect disappears after additional covariates are added. The coefficients on fraction foreign-born, state contributions, and county mean income are also stable after controlling for the age distribution (Column (7)) and the county poverty rate (Column (8)).

Finally, I perform the estimation again while excluding the 2007 observations from analysis. This is in order to avoid confounding effects induced by the Great Recession that may have started earlier than 2007. Table 1.8 reports the coefficient estimates for the state-level regression. Compared to the estimates from the full sample (Table 1.6), the magnitudes are slightly lower, but are still insignificant. Table 1.9 reports estimates for local-level regressions. Compared to the estimates from the full sample (Table 1.7), these estimates are larger in magnitude but have the same sign. These estimates from the restricted samples are consistent with the model implications.

## 1.7 Conclusion

Although there is a broad literature documenting a negative association between immigration and public education spending, much of the focus has been on identifying social mechanisms through which this impact propagates. In this paper, I revisit the causal effect of immigration on education finance by focusing on the fiscal impact of immigration. I develop a model that considers the separate responses of state and local governments to immigration, observing that traditional analyses of education finance that use current education spending as the fiscal variable of interest do not tell a complete story about the

impact of immigration. My analysis of state and local government responses shows that there is no evidence that state governments respond to immigration, but that local governments respond significantly, decreasing education spending by 7.4% when immigration increases by 1 percentage point, about \$319 when evaluated at the 2007 average county revenue level. This effect corresponds to an elasticity of -0.43.

This paper finds that the resistance to inflows of low-income immigrants evidenced by decreasing public education revenues in locales with high immigration can be rationalized by the fact that education is now more expensive. In particular, it provides a political economy justification for why the U.S. voter may appear xenophobic, and a closer examination in the context of public education provision reveals that the purely monetary aspect of the cost of immigration explains this phenomenon. Furthermore, if the negative effect on education revenues by immigration is not ideal, then this paper motivates a potential solution: since state revenues do not respond to immigration, placing more of the responsibility of education funding to the state would reduce expenditure differentials within states.

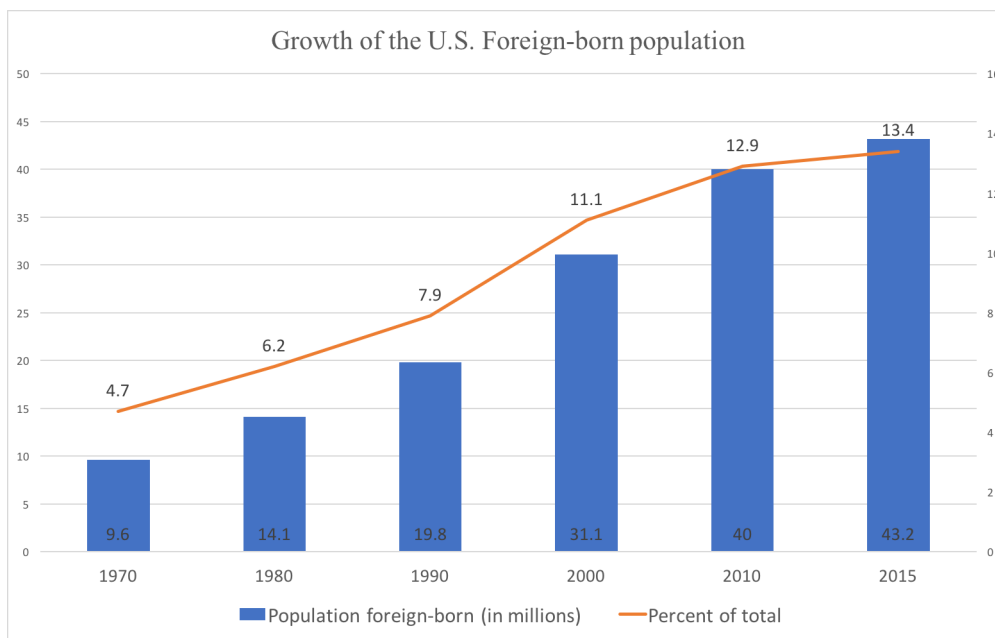
An open avenue for future research is to further explore extensions of this model, particularly in two dimensions. First, the native-born can respond to an influx of immigrants by sending their children to private school. Private schooling<sup>17</sup> is a private good that substitutes for the public good, so I would expect to see a larger increase in the tax price of education in response to immigration as native families opt to exit the public education system. Second, additional research is needed to study how the education funding decisions change as immigrants naturalize and become natives themselves. Immigrants naturalizing would affect native income as the composition of natives changes, and I would expect that the effect of immigration on education funding weakens as immigrants and natives become more similar in income.

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<sup>17</sup>Epplé and Romano (1996) model household choice when private schooling is available as an alternative to public education.

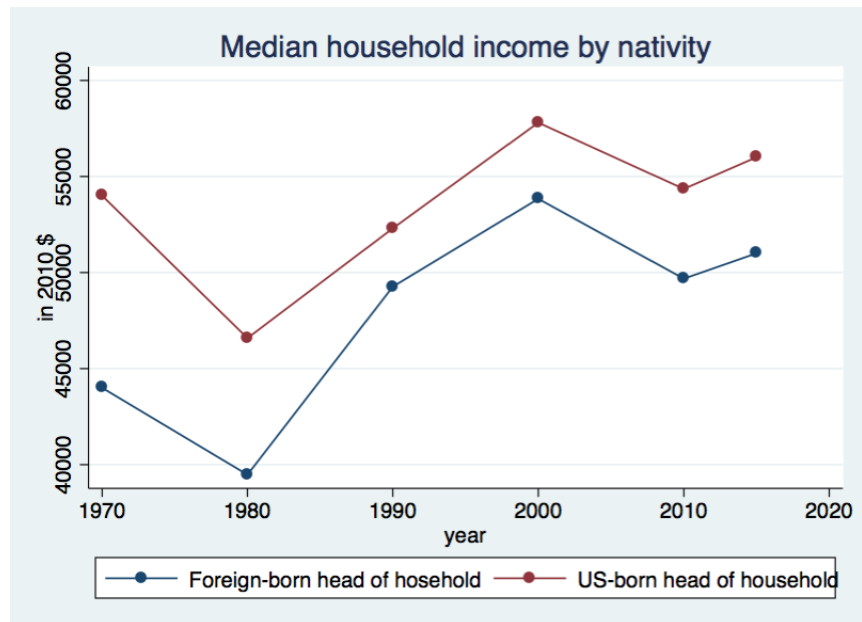
## 1.8 Figures

Figure 1.1: Growth of the U.S. foreign-born population



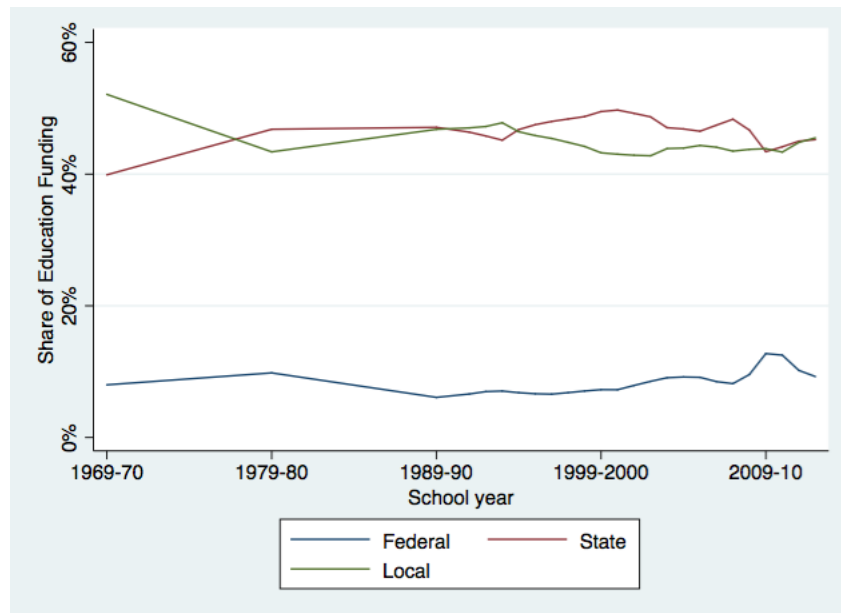
This figure shows the growth of the United States foreign-born population every decade from 1970 to 2015. The number of foreign-born residents has been increasing over the past five decades. As the immigrant population grows in numbers and as a share of population, it is increasingly important to analyze their fiscal impact on the communities they move to.

Figure 1.2: Mean household income over time, by nativity of the head of household



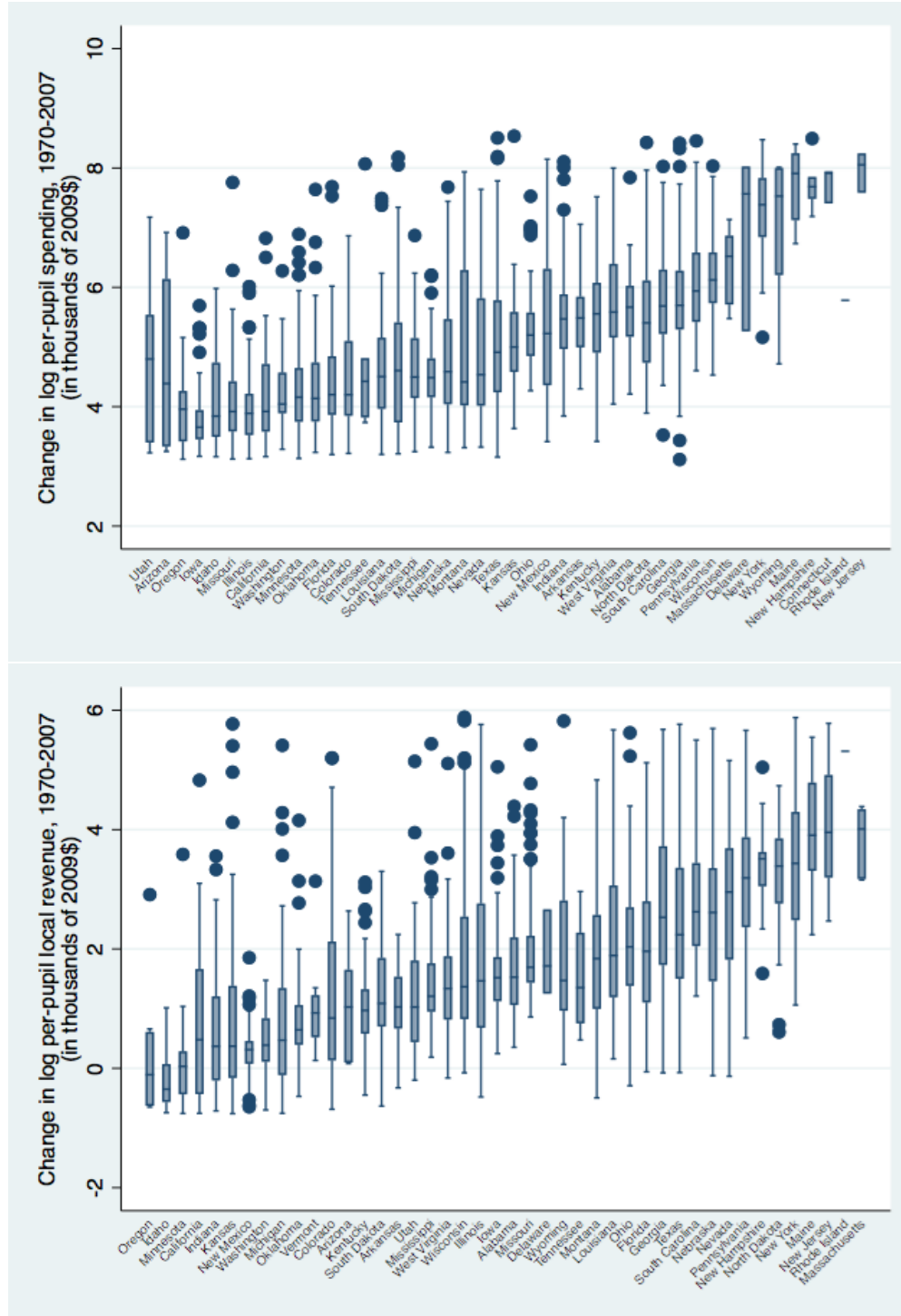
This figure illustrates one of the major differences between foreign-born and native households. Households with heads that are foreign-born have lower median incomes than households with heads that are US-born. This relationship persists from 1970 to present.

Figure 1.3: Share of K-12 education revenue by source



Historically, most of the responsibility to fund K-12 education lies with state and local districts. Approximately 45% of total K-12 education funding is raised by state governments, and a roughly equal amount is from local governments, while about 9% comes from the Federal government. These shares have remained fairly constant over time, outside of an increase in Federal funds beginning in the Great Recession.

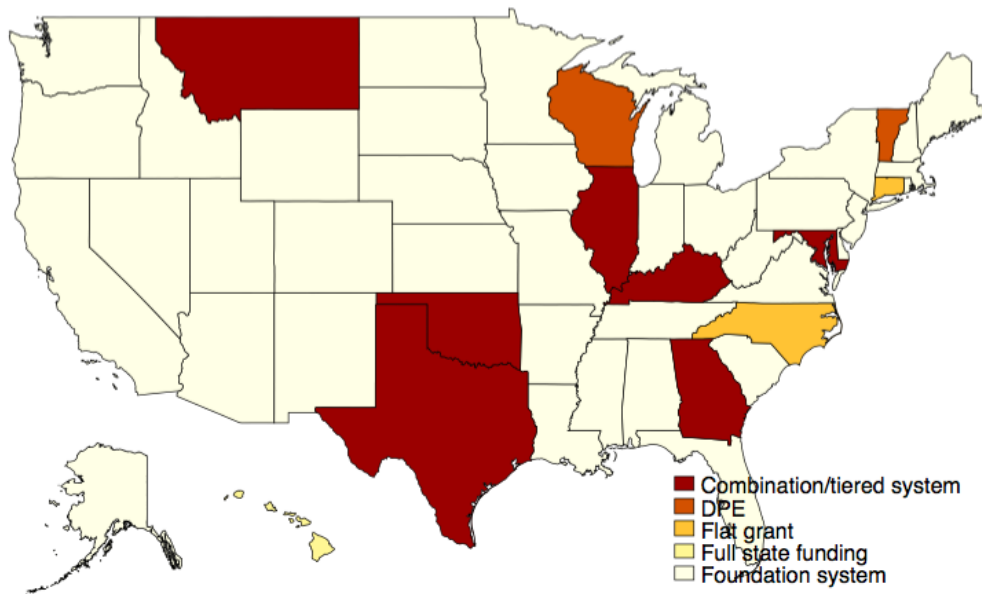
Figure 1.4: Variation in total education spending



There is a large variation in within-state per-pupil total spending (top panel). However, there is just as much variation in per-pupil within-state local district education revenues. Analyses that only look at total spending ignore the nuances that can be studied with a model that looks at the components of total spending.

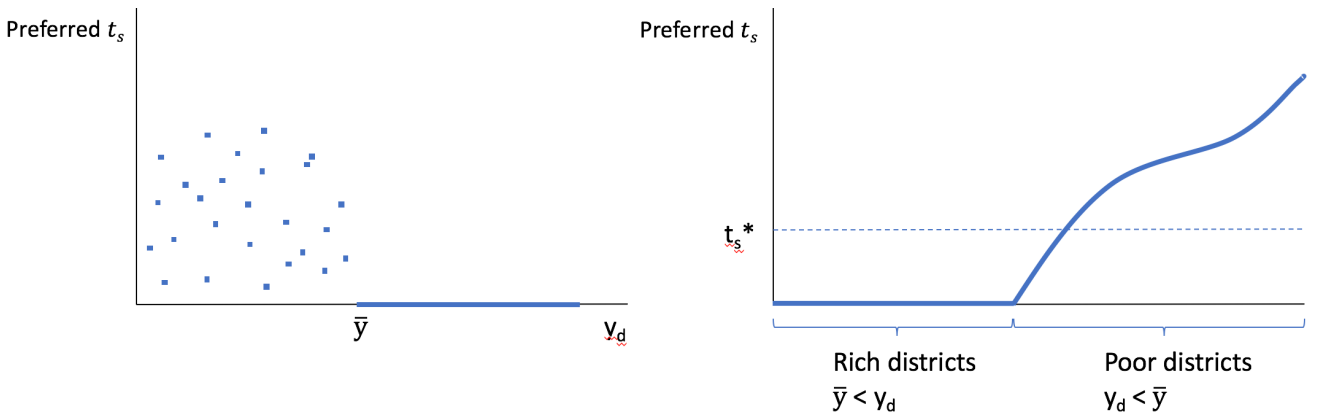


Figure 1.5: State education funding systems, 2007



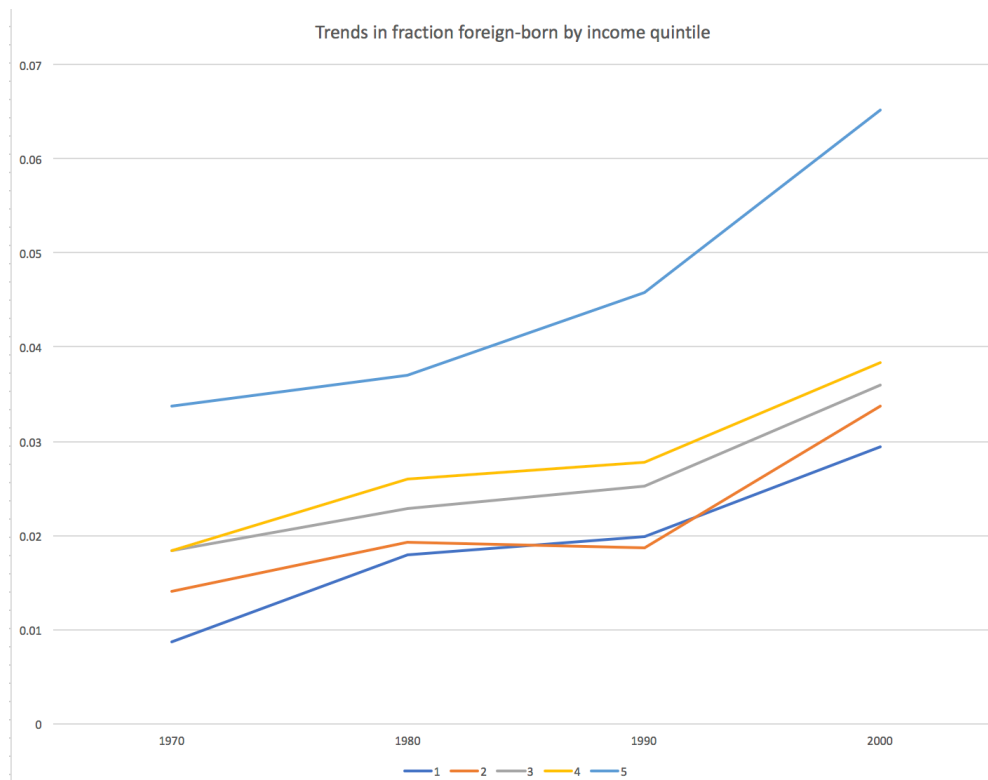
This shows the properties of education funding systems used by states as of FY 2007, using survey data and the categorization of Verstegen (2011). The vast majority of states (45) use a state foundation system of some form. The model described in this paper is based on a state foundation system.

Figure 1.6: Preferred state tax rates



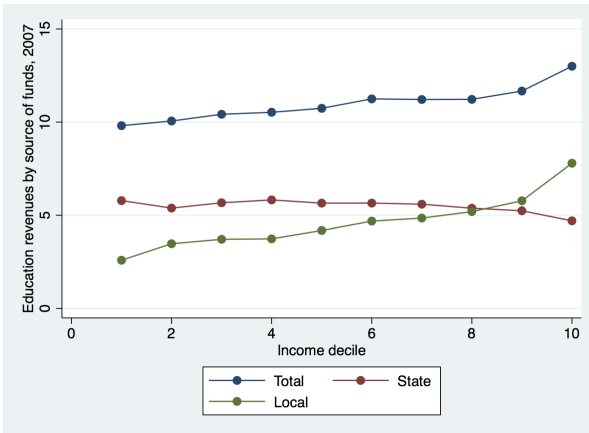
The left panel illustrates the relationship between district income,  $y_d$ , and districts' preferred state tax rates. Rich district (those for which  $\bar{y} < y_d$ ) prefer purely local funding, where  $t_s = 0$ . Poor districts prefer  $t_s > 0$ . As long as the mass of rich districts is less than 0.5 (or, mean state income is higher than the median), the tax rate chosen by state legislators,  $t_s^*$ , is positive, and the state will provide a positive amount of education revenues

Figure 1.7: The relationship between wealth and immigration

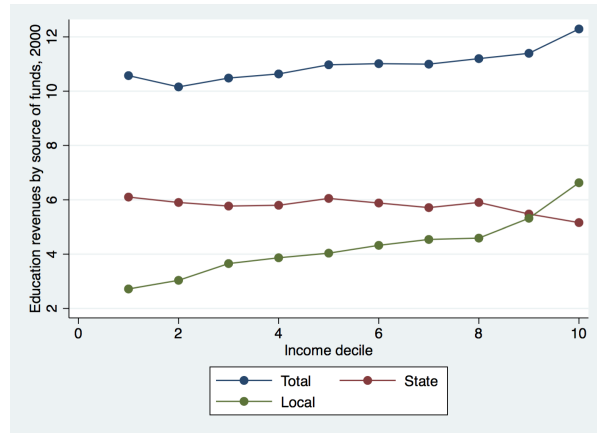


Wealthier districts, particularly the top quintile, attract more immigrants. To the extent that wealth is correlated to more favorable labor market conditions or other variables that affect both education revenues and immigration, OLS estimates may be biased. An instrument is necessary to capture the unbiased causal effect of immigration and education finance.

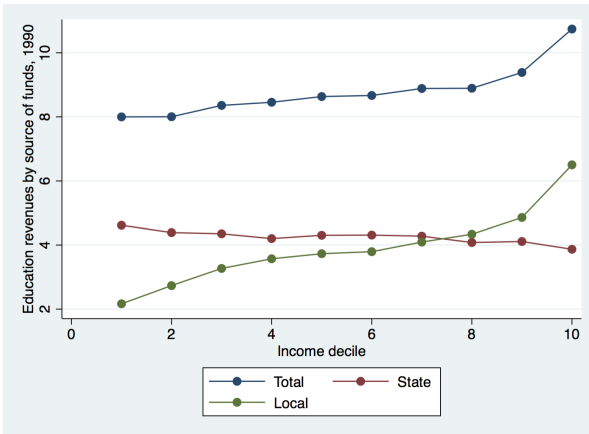
Figure 1.8: Education revenue by source and income, 1970-2007



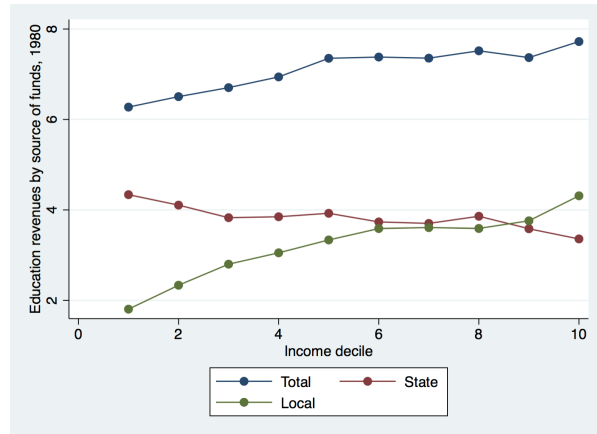
(a) 2007



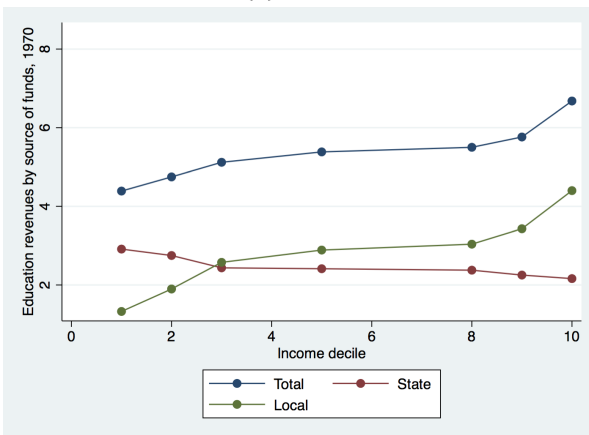
(b) 2000



(c) 1990



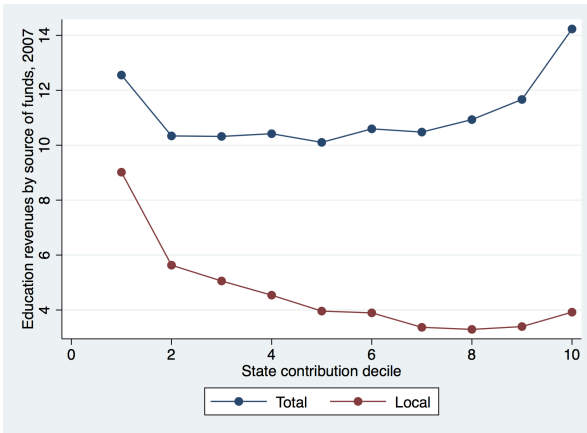
(d) 1980



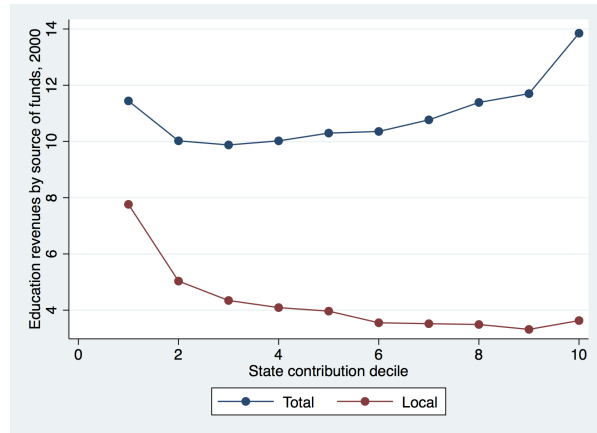
(e) 1970

The relationship between education revenue by source and county-level income deciles. Total education contributions and state contributions are weakly increasing in income, while state contributions are weakly decreasing in income for all years in the sample.

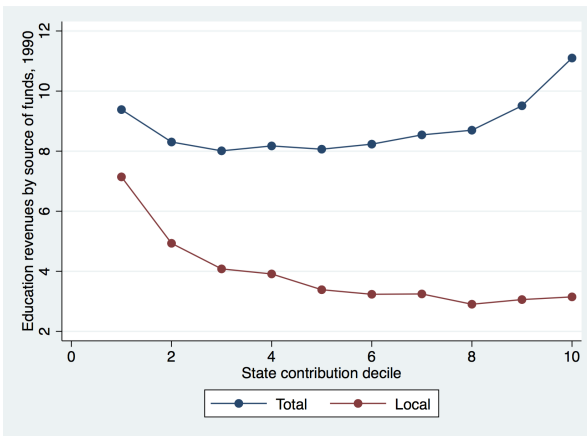
Figure 1.9: Education revenue by source and state contributions, 1970-2007



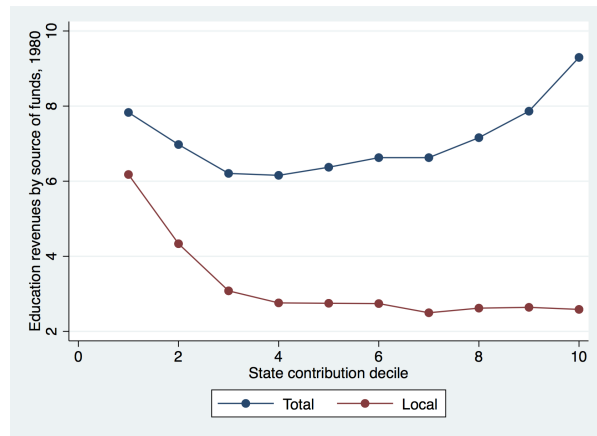
(a) 2007



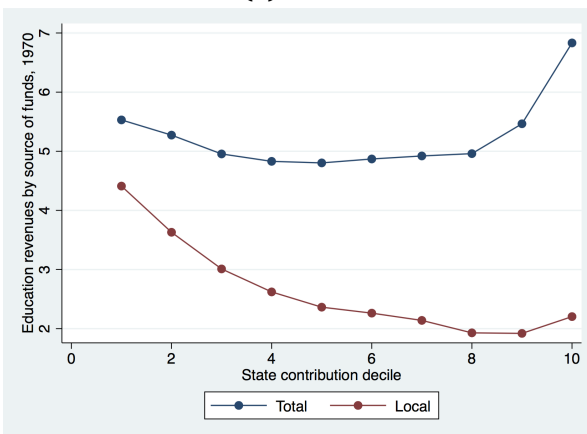
(b) 2000



(c) 1990



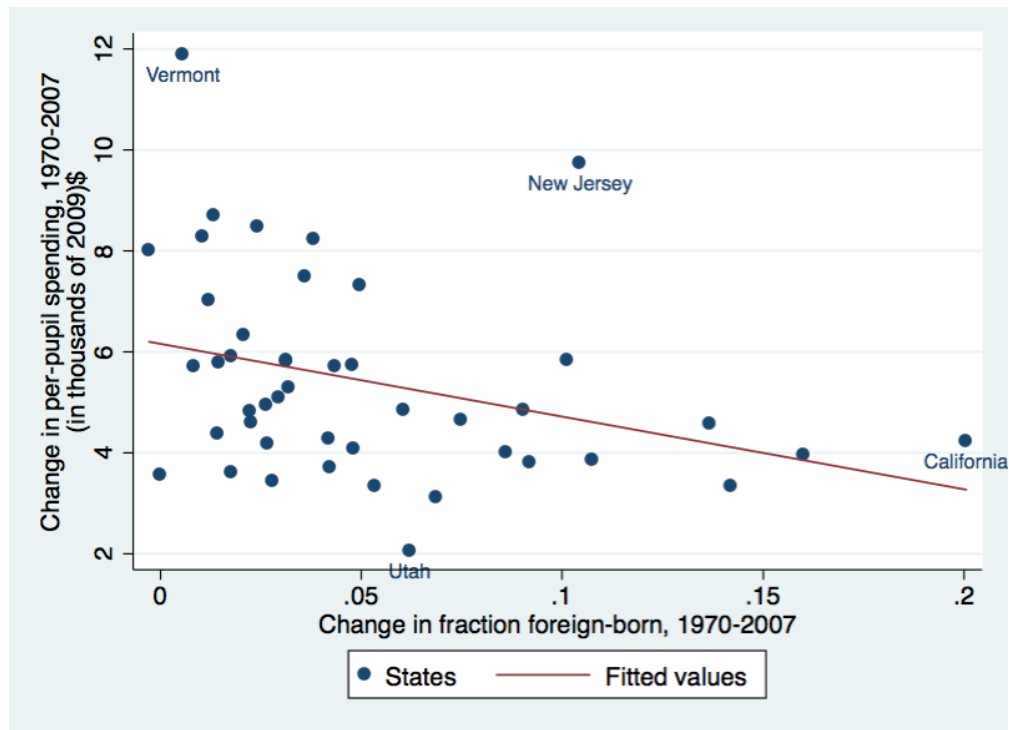
(d) 1980



(e) 1970

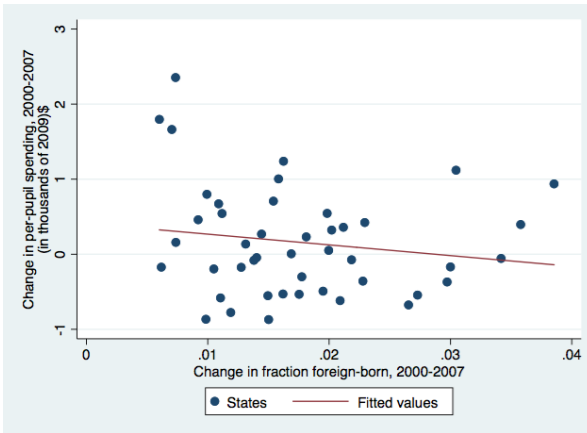
The relationship between total education revenue, from local sources and state education revenue deciles. Total education contributions are first decreasing and then increasing as state contributions increase. Local education revenues are high for low levels of state contribution, and fall rapidly. At higher levels of state contributions, local education revenues are flat. This general pattern holds for all years in the sample.

Figure 1.10: Immigration and education spending, 1970-2007

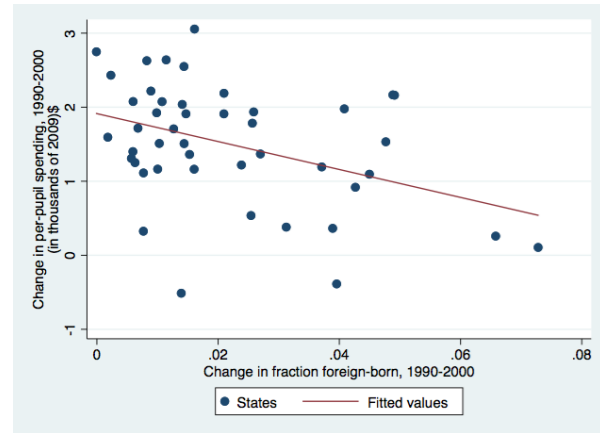


Correlation = -0.3274. There is a clear negative relationship between the change in the fraction foreign-born between 1970 and 2007 and the corresponding change in total current spending.

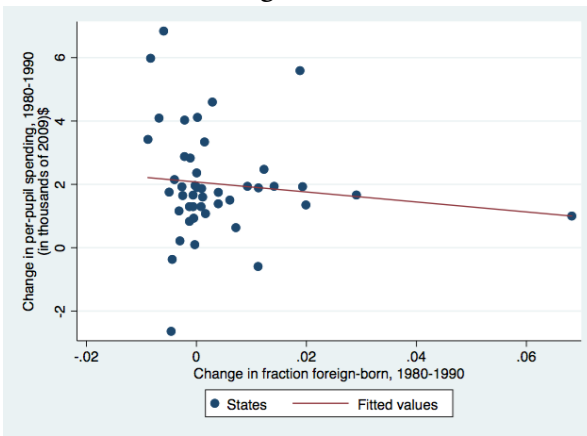
Figure 1.11: Immigration and education spending, shorter time periods



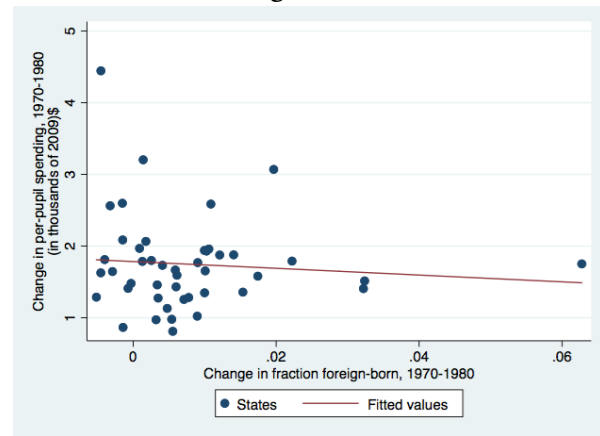
(a) Changes 2000-2007



(b) Changes 1990-2000



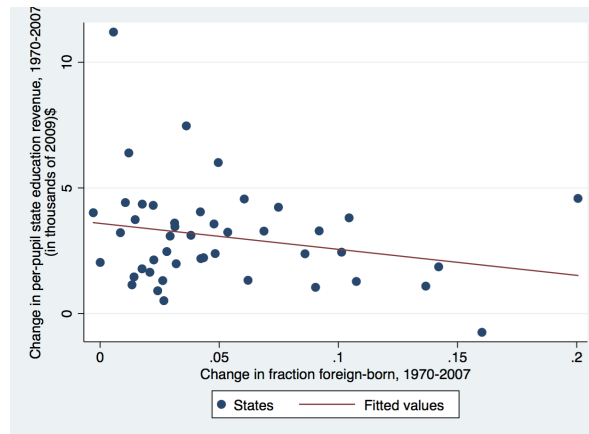
(c) Changes 1980-1990



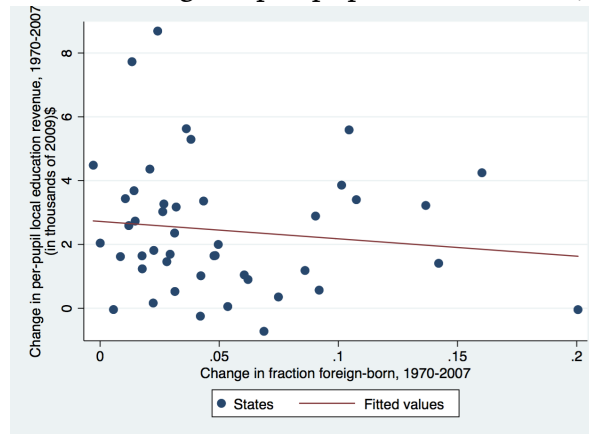
(d) Changes 1970-1980

States with higher increases in the fraction of foreign-born population also have lower increases in per-pupil current spending. The negative relationship between the change in the fraction foreign-born and the corresponding change in total spending is evident even with shorter differences.

Figure 1.12: Immigration and state and local revenue



(a)  $\rho = -0.2312$ . Change in per-pupil state revenue, 1970-2007



(b)  $\rho = -0.1211$ . Change in per-pupil local revenues, 1970-2007

Trends in the change in the fraction foreign-born and changes in education revenue by source. The negative correlation between state and local education revenues is visible even in long differences.



## 1.9 Tables

Table 1.1: Summary of model predictions

Variable	State revenue	Local revenue
Fraction foreign-born, $\Delta Imm_{d,t}$ ( $\beta_1$ )	0	Negative
Median income, $\Delta Inc_{d,t}$ ( $\beta_2$ )	Negative	Positive
State contributions, $\Delta StateRev$ ( $\beta_3$ )	-	Negative (low state funds) 0 (high state funds)

This table summarizes the predictions of the model on the signs of the coefficients of different variables in (1.19) and (1.20).

Table 1.2: State revenue level regressions using OLS

	(1)	(2)	(3)	(4)
	log(State revenue)	log(State revenue)	log(State revenue)	log(State revenue)
Fraction foreign-born	-1.044*** (0.188)	-0.927*** (0.195)	-0.895*** (0.193)	-0.978*** (0.191)
Median income	-0.373*** (0.0266)	-0.305*** (0.0330)	-0.319*** (0.0337)	-0.0820 (0.0620)
Fraction college		-0.393*** (0.109)	-0.430*** (0.111)	-0.652*** (0.124)
Fraction under age 18			-0.404* (0.175)	-0.721*** (0.184)
Fraction above age 65			-0.254 (0.152)	-0.228 (0.153)
Poverty rate				0.791*** (0.158)
Observations	7268	7268	7268	7268

Standard errors in parentheses

\*  $p < 0.05$ , \*\*  $p < 0.01$ , \*\*\*  $p < 0.001$ 

The unit of analysis is the county. The dependent variable is the logarithm of state contributions to public education allocated to the county, deflated by the National Income and Products Accounts deflator for government purchases of goods and services. All variables are first-differenced. The specifications include year- and state-fixed effects, and the standard errors are clustered at the county level.

Table 1.3: Local revenue level regressions using OLS

	(1) log(Local revenue)	(2) log(Local revenue)	(3) log(Local revenue)	(4) log(Local revenue)
Fraction foreign-born	0.219 (0.183)	0.0871 (0.186)	0.401* (0.183)	0.423* (0.183)
State contributions	-0.287*** (0.0172)	-0.285*** (0.0173)	-0.292*** (0.0174)	-0.291*** (0.0174)
Median income	0.757*** (0.0306)	0.680*** (0.0366)	0.719*** (0.0373)	0.660*** (0.0612)
Fraction college		0.457*** (0.122)	0.355** (0.122)	0.411** (0.130)
Fraction under age 18			-1.449*** (0.206)	-1.369*** (0.210)
Fraction above age 65			0.615*** (0.155)	0.609*** (0.156)
Poverty rate				-0.196 (0.168)
Observations	7268	7268	7268	7268

Standard errors in parentheses

\*  $p < 0.05$ , \*\*  $p < 0.01$ , \*\*\*  $p < 0.001$ 

The unit of analysis is the county. The dependent variable is the logarithm of local contributions to public education raised by the county, deflated by the National Income and Products Accounts deflator for government purchases of goods and services. All variables are first-differenced. The specifications include year- and state-fixed effects, and the standard errors are clustered at the county level.

Table 1.4: IV credibility estimates

First-stage regression	
Endogenous variable: % Foreign-born	
Basic specification	Includes $\Delta StateRev$ as regressor
IV 0.1786***	0.1783***
F-stat = 25.96	F-stat = 25.81

The table below contains the first-stage regressions of the instrument described in subsection 1.5.2. The first column is the first-stage using the largest set of county-level covariates. The second column includes the change in state contributions to education funding in the county as a regressor.

Table 1.5: IV falsification tests, 1965-1970

	State revenues		Local revenues	
IV	-1.65	-1.36	-2.90	-2.12
	(2.65)	(3.04)	(3.37)	(4.21)
Excludes CA, TX	X		X	

This table tests the exogeneity assumption for the validity of the IV estimation. I test whether the instrument is related the pre-existing trend in changes in state education revenue and local education revenue allocated to the district. To assuage concerns about whether the traditional immigrant states are driving this relationship, I test this relationship for states excluding CA and TX.

Table 1.6: Estimates of effects on per-pupil state revenue, 1970-2007

	OLS estimates log(State revenue)				IV estimates log(State revenue)			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Fraction foreign-born	-0.591* (0.256)	-0.548* (0.261)	-0.351 (0.263)	-0.421 (0.266)	-2.807 (1.516)	-2.738 (1.590)	-2.279 (1.572)	-2.094 (1.528)
Median income	-0.114* (0.0480)	-0.103* (0.0484)	-0.103* (0.0478)	-0.0192 (0.0523)	-0.126** (0.0489)	-0.121* (0.0507)	-0.119* (0.0502)	-0.0185 (0.0520)
Fraction college		-0.280 (0.200)	-0.256 (0.201)	-0.356 (0.209)		-0.117 (0.243)	-0.116 (0.240)	-0.253 (0.238)
Fraction under age 18			-1.319*** (0.218)	-1.339*** (0.217)			-1.166*** (0.242)	-1.210*** (0.238)
Fraction above age 65			-0.209 (0.203)	-0.188 (0.203)			-0.181 (0.204)	-0.160 (0.205)
Poverty rate				0.354* (0.139)				0.414** (0.147)
Constant	0.478*** (0.0115)	0.486*** (0.0126)	0.415*** (0.0168)	0.432*** (0.0191)	0.108* (0.0419)	0.110** (0.0413)	-0.224* (0.0953)	-0.236* (0.0948)
Observations	7251	7251	7251	7251	7251	7251	7251	7251

Standard errors in parentheses

\*  $p < 0.05$ , \*\*  $p < 0.01$ , \*\*\*  $p < 0.001$ 

The unit of analysis is the county. The dependent variable is the logarithm of state contributions to public education allocated to the county, deflated by the National Income and Products Accounts deflator for government purchases of goods and services. All variables are first-differenced. The specifications include year- and state-fixed effects, and the standard errors are clustered at the county level.

Table 1.7: Estimates of effects on per-pupil local revenue, 1970-2007

	OLS estimates log(Local revenue)				IV estimates log(Local revenue)			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Fraction foreign-born	-0.957*** (0.219)	-1.138*** (0.224)	-0.895*** (0.231)	-0.898*** (0.234)	-7.246*** (2.188)	-8.253*** (2.388)	-7.504** (2.340)	-7.392** (2.279)
State contributions	-0.151*** (0.0177)	-0.149*** (0.0176)	-0.158*** (0.0173)	-0.158*** (0.0173)	-0.158*** (0.0179)	-0.157*** (0.0179)	-0.162*** (0.0175)	-0.163*** (0.0175)
Median income	0.410*** (0.0489)	0.365*** (0.0511)	0.354*** (0.0511)	0.358*** (0.0589)	0.375*** (0.0516)	0.305*** (0.0568)	0.299*** (0.0565)	0.360*** (0.0594)
Fraction college		1.167*** (0.200)	1.186*** (0.201)	1.181*** (0.206)		1.697*** (0.294)	1.664*** (0.287)	1.580*** (0.272)
Fraction under age 18			-1.778*** (0.224)	-1.779*** (0.224)			-1.260*** (0.285)	-1.288*** (0.279)
Fraction above age 65			-0.741*** (0.191)	-0.740*** (0.191)			-0.647** (0.202)	-0.635** (0.203)
Poverty rate				0.0165 (0.138)				0.254 (0.164)
Constant	0.345*** (0.0219)	0.308*** (0.0222)	0.225*** (0.0255)	0.226*** (0.0257)	0.0701* (0.0343)	0.0380 (0.0349)	-0.381*** (0.102)	-0.388*** (0.0999)
Observations	7251	7251	7251	7251	7251	7251	7251	7251

Standard errors in parentheses

\*  $p < 0.05$ , \*\*  $p < 0.01$ , \*\*\*  $p < 0.001$ 

The unit of analysis is the county. The dependent variable is the logarithm of local contributions to public education raised by the county, deflated by the National Income and Products Accounts deflator for government purchases of goods and services. All variables are first-differenced. The specifications include year- and state-fixed effects, and the standard errors are clustered at the county level.

Table 1.8: Robustness to excluding 2007: estimates of effects on per-pupil state revenue, 1970-2000

	OLS estimates log(State revenue)				IV estimates log(State revenue)			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Fraction foreign-born	-0.634* (0.289)	-0.586* (0.295)	-0.301 (0.296)	-0.374 (0.300)	-3.050 (1.674)	-2.965 (1.735)	-2.736 (1.659)	-2.520 (1.604)
Median income	-0.127* (0.0505)	-0.115* (0.0508)	-0.107* (0.0502)	-0.0210 (0.0556)	-0.137** (0.0510)	-0.130* (0.0524)	-0.127* (0.0525)	-0.0209 (0.0553)
Fraction college		-0.331 (0.224)	-0.301 (0.224)	-0.411 (0.235)		-0.166 (0.265)	-0.148 (0.256)	-0.301 (0.256)
Fraction under age 18			-1.951*** (0.290)	-1.962*** (0.289)			-1.769*** (0.303)	-1.804*** (0.299)
Fraction above age 65			-0.00437 (0.337)	0.0512 (0.339)			-0.179 (0.349)	-0.0901 (0.348)
Poverty rate				0.357* (0.149)				0.433** (0.157)
Constant	0.460*** (0.0115)	0.471*** (0.0131)	0.356*** (0.0208)	0.374*** (0.0234)	0.426*** (0.0446)	0.430*** (0.0442)	0.396*** (0.0432)	0.396*** (0.0431)
Observations	6203	6203	6203	6203	6203	6203	6203	6203

Standard errors in parentheses

\*  $p < 0.05$ , \*\*  $p < 0.01$ , \*\*\*  $p < 0.001$ 

The unit of analysis is the county. The dependent variable is the logarithm of state contributions to public education allocated to the county, deflated by the National Income and Products Accounts deflator for government purchases of goods and services. All variables are first-differenced. The specifications include year- and state-fixed effects, and the standard errors are clustered at the county level.

Table 1.9: Robustness to excluding 2007: estimates of effects on per-pupil local revenue, 1970-2000

	OLS estimates log(Local revenue)				IV estimates log(Local revenue)			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Fraction foreign-born	-1.015*** (0.246)	-1.201*** (0.250)	-0.888*** (0.264)	-0.903*** (0.267)	-6.255** (2.149)	-7.131** (2.307)	-6.542** (2.135)	-6.412** (2.074)
State contributions	-0.160*** (0.0187)	-0.158*** (0.0185)	-0.172*** (0.0181)	-0.172*** (0.0181)	-0.166*** (0.0187)	-0.165*** (0.0186)	-0.175*** (0.0181)	-0.176*** (0.0182)
Median income	0.382*** (0.0517)	0.334*** (0.0539)	0.334*** (0.0546)	0.352*** (0.0637)	0.360*** (0.0534)	0.294*** (0.0576)	0.286*** (0.0588)	0.352*** (0.0638)
Fraction college		1.298*** (0.221)	1.312*** (0.222)	1.290*** (0.229)		1.707*** (0.298)	1.666*** (0.283)	1.572*** (0.274)
Fraction under age 18			-2.452*** (0.308)	-2.455*** (0.308)			-2.035*** (0.342)	-2.059*** (0.339)
Fraction above age 65			-0.348 (0.325)	-0.337 (0.324)			-0.754* (0.355)	-0.699* (0.348)
Poverty rate				0.0729 (0.148)				0.267 (0.165)
Constant	0.378*** (0.0245)	0.337*** (0.0248)	0.206*** (0.0311)	0.209*** (0.0313)	0.202*** (0.0388)	0.159*** (0.0396)	0.125** (0.0415)	0.126** (0.0410)
Observations	6203	6203	6203	6203	6203	6203	6203	6203

Standard errors in parentheses

\*  $p < 0.05$ , \*\*  $p < 0.01$ , \*\*\*  $p < 0.001$ 

The unit of analysis is the county. The dependent variable is the logarithm of local contributions to public education raised by the county, deflated by the National Income and Products Accounts deflator for government purchases of goods and services. All variables are first-differenced. The specifications include year- and state-fixed effects, and the standard errors are clustered at the county level.



## CHAPTER II

# The Impact of the Great Recession on K-12 Public Education Finance

## 2.1 Introduction

In this paper, I analyze the impact of increased Federal education contributions on state and district education revenues. I use increases in Federal education grants induced by the American Recovery and Reinvestment Act (“Recovery Act”, “ARRA”) to identify this impact by exploiting the formulaic nature of Federal grant allocations that affected school districts differentially. This approach also allows me to decompose the impact based on whether the increased grants were channeled through existing Federal grant programs or new, temporary grant programs.

The Great Recession was the worst economic downturn in the United States since the 1930s. At its height, the US government introduced anti-recession measures with the Recovery Act in 2009. The Recovery Act resulted in increased Federal spending intended to offset slowdowns in spending by other economic sectors.

K-12 public education was one of the areas that received significant additional funding, and as a result, the Federal government took on a larger fraction of district education budgets. Figure 2.1 shows how the composition of K-12 education revenue changed around the implementation of the Recovery Act, indicated by the vertical red line. The Federal share of education revenues increased from 8% in 2008 to a peak of 12% in 2010.

The same pattern is even starker in dollar terms. Figure 2.2 illustrates the average amount of per-pupil Federal, state and local contributions to education for 2005-2013. The average amount received by school districts from the Federal government increased from about \$850 in 2008 to \$1300 in 2009, an increase of approximately 50%, before decreasing to its pre-recession level. In contrast, state contributions declined sharply after 2009, and stayed low thereafter. Local education contributions did not experience a similar trend break around the recession.

My research question relates to the “flypaper effect” of education grants. Theoretically, government funds are fungible, so the source of funds should not affect how and where these funds are spent. In practice, however, increased intergovernmental grants raise spending by more than the theoretical prediction.<sup>1</sup> As a result, intergovernmental grants intended for specific purposes do not only crowd out other funds, but also affect the distribution of spending.

Hines and Thaler (1995) survey the flypaper effect literature. Empirical estimates in a large variety of contexts are mixed; an additional dollar of grants is found to increase spending by local agencies by \$0.25 to \$1. Various papers have studied the flypaper effect of education grants in the context of education spending. Fisher and Papke (2000) survey some of this literature. Many of the papers that analyze expansions of Federal grants focus on Title 1, a large Federal grants program designed to support poor students’ educational services and achievement. Nevertheless, even in this more specific context, estimates of the impact of increases in Federal spending are mixed. Feldstein (1978) estimates that a dollar of additional Title 1 grants results in an increase of \$0.72 in total spending. Gordon (2004) used changes in per-pupil grant allocations caused by updates in Census-derived measurements to identify the effect of Title 1 on state and education revenues. She finds that state and local revenue efforts are unaffected by Title 1 changes in the short term, so that spending increases dollar to dollar. However, the effect is temporary, as local governments crowd out Title 1 grants within 3 years. Cascio et al. (2013) analyzed the effects of the introduction of Title 1 of the 1965 Elementary and Secondary Education Act on education spending in the South. They find that on average, an additional dollar of Title 1 funds increased local spending by only \$0.50.

This paper builds on the existing literature relating to education finance in general, and makes two key contributions. First, I evaluate the effect of a large expansion of Federal funding on state and local education spending in the broader context of the Great Recession. Other papers that have examined the impact of the Great Recession on education have focused on the specific experience of schools in New York and New Jersey (Chakrabarti et al. (2013), Chakrabarti and Setren (2015), Bhalla et al. (2017)).

Second, I consider both permanent programs (that is, expansions of Federal grant programs that already existed prior to the recession) and temporary Federal grant programs (one-time cash infusions) and study how fiscal responses to each type of grant differ. Earlier literature in public education finance has focused solely on permanent expansions like the introduction of key Federal grant programs or changes in the underlying district characteristics that drive the formulas used to allocate these grants. Permanent expansions are

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<sup>1</sup>The money “sticks where it hits,” hence the term “flypaper effect.”

likely to have different effects compared to the short-term expansions, so it is important to differentiate between them when analyzing expansions of Federal grant programs.

The rest of the paper is organized as follows. Section 2.2 describes the institutional background of US education finance and the Recovery Act. Section 2.3 describes the data used in this analysis. In Section 2.4, I describe the estimation strategy and the underlying identification assumptions. In Section 2.5, I describe my results. Finally, Section 2.6 concludes.

## **2.2 Institutional background**

This section consists of two parts. In the first, I describe the roles of different government entities over K-12 education funding. In the second, I describe the Recovery Act, the context in which it was introduced, and its implications for education finance.

### **2.2.1 K-12 education finance at the Federal level**

Historically, the Federal government has not had a large role in funding K-12 education, and most of the funds for education in the US is primarily sourced at the state and local level. Federal sources account for about 8% of total spending. Figure 2.1 shows the evolution of Federal, state, and local contributions over time. Although the shares have remained fairly constant during the time period of interest, it is clear that around the same time as the Great Recession, these shares shifted notably.

Federal funding is driven by two large programs: Title 1 and IDEA Special Education grants. The remainder of all Federal grants, about 1/3 of the total, is made up of smaller programs including ESL programs and competitive teacher incentive grants.

Title 1 grants were legislated with the passing of the Elementary and Secondary Education Act (ESEA), as part of President Lyndon Johnson’s “War on Poverty” in 1965. ESEA is the most extensive legislation regarding Federal funding for education, and Title 1 continues to be the largest federal program for K-12 education. The Title 1 grant program is targeted toward low-income students, and funds are distributed according to school districts’ poverty, enrollment, and the average per-pupil expenditures in the state. Specifically, Title 1 funds are allocated by formula based on relative population aged 5-24, and relative total population.<sup>2</sup> Because Title 1 grants are tied to child poverty rates, states and districts that have higher poverty rates tend to receive larger grants. The vast majority of school

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<sup>2</sup>Title 1 consists for four separate grant programs. More details about how Title 1 funds are allocated can be found in the Department of Education website, <https://www2.ed.gov/programs/titleiparta/index.html>

districts (84.8% in my final sample, described in the next section) received some Federal Title 1 grants in 2007.

IDEA Special Education grants are so named because they were created with the passing of the Individuals with Disabilities in Education Act (“IDEA”) in 1990. These grants are funds targeted towards students with disabilities. These grants are provided to the states, which must then decide to allocate these funds to their constituent school districts. While formulas used to allocate funds vary across states, generally funding goes to school districts with larger shares of students with disabilities (Cullen (2003)). Similar to Title 1 grants, most school districts (68% in my sample) received some Special Education funds in 2007.

### **2.2.2 The American Recovery and Reinvestment Act**

President Barack Obama signed the ARRA into law in February 2009, which was a policy response and a key element of the government’s effort against the recession that began in late 2007 and accelerated during 2008. The Recovery Act provided \$840 billion in new spending, about \$98 billion of which was designated for education. The stated purpose of these funds was to stabilize state and local government budgets, by increasing government spending to make up for contractions elsewhere.

The Department of Education determined allocations at the state level, and stimulus funds were released to states beginning in April 2009. State governments had discretion over when the funds were released to local school districts, but were allowed until September 2011 to do so for all three programs.

The majority of ARRA education funds, about 80%, was spent on K-12 education. First, Recovery Act funds were used to bolster the two major Federal education grant programs: \$13 billion was distributed through the Title 1 program, and \$12.2 billion through IDEA Special Ed grants. Second, the Federal government created a new, one-time appropriation of \$53.6 billion, called the State Fiscal Stabilization Fund (“SFSF”). A smaller fraction of ARRA education funds, \$17.1 billion, went to Pell grants, which are for higher (post-secondary) education. The remainder, about \$2.3 billion, was earmarked for technology improvements and teacher incentive grants, which went to both K-12 and higher-education. A summary of the Recovery Act allocations is available in Table 2.1.

The SFSF was by far the largest component of Recovery Act education funds. Of the \$53.6 billion in new funding, \$48.3 billion was awarded to states to support public elementary, secondary, and higher education programs and services in their constituent school districts. The remaining \$5.3 billion was used by the Department of Education to make

competitive grants through the “Race to the Top” and the “Invest in What Works and Innovation” funds.<sup>3</sup>

Chakrabarti et al. (2013) study the impact of SFSF in New Jersey, and find that stimulus funds were substituted in for declining state funding during the recession. Furthermore, after SFSF funds were exhausted in 2011, total spending fell because state and local spending did not increase enough to make up for the loss of SFSF funds. Chakrabarti and Setren (2015) use trend shift analysis to show that the federal stimulus offset declines in state and local funding in New York State school districts in the 2009-2010 school year. As a result, the recession did not strongly impact overall spending in the state. Bhalla et al. (2017) compares the experiences of New York and New Jersey during the recession. They show that New York was more successful than New Jersey in minimizing the impact of the Great Recession. NJ experienced large cuts in state revenues which resulted in lower per-pupil spending relative to NY in 2009 and 2010. Finally, Evans et al. (2017) studied the impact of the Great Recession on U.S. schools, focusing on the SFSF. They find that the SFSF caused decreases in state support for education, but had minimal effect on local support. This meant that districts that were highly reliant on state funding were disproportionately affected by the recession.

States were allowed to decide when to release the additional Title 1, IDEA special education, and SFSF funds to school districts, as long as all the funds were distributed by the end of Fiscal Year 2011. The SFSF, however, had relatively minimal conditions. States were required to meet a Maintenance of Effort provision, which required states that received SFSF funds to maintain K-12 and higher education spending at their 2006 level. However, states could request waivers from this requirement, so this condition was very easily met, or was nonbinding on the states.

## **2.3 Data and sample selection**

To begin an analysis of how the Recovery Act funds affected state and local education revenues, I first construct panel data on school district finances and demographics from 2005 to 2013, covering both pre- and post-implementation of the Recovery Act.

School district financial data is sourced from the National Center for Education (NCES) Common Core’s Local Education Agency (School District) Universe Survey and the F-33 Local Education Agency (School District) Finance Survey, which together include information on all U.S. school district finances, including charter schools and other special purpose school districts. The Universe Survey data sets contain information on school district stu-

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<sup>3</sup>U.S. Department of Education Law and Guidance Brief, 2012.

dent characteristics like enrollment, race distribution, and students with special needs. The F-33 data sets contain comprehensive information regarding school district budgets, and sources of education revenue, including the amount that is received from various Federal grant programs, states, and local districts.

In addition to the NCES, district information is also sourced from the Census's Small Area Income and Poverty Estimates (SAIPE), which has information on school district poverty rates, and is available for years 1995 and later. These poverty measures are the ones used by the Federal government to allocate Title 1 grants to school districts, and will be used to construct the Title 1 element of the instrument described in the next section.

Finally, Recovery Act funding allocations are from the Department of Education's published reports (Garrison-Mogren and Gutmann (2012)). This data is only at the state level, and is used primarily to create instrumental variables. Together, these data sets allow me to construct panel data at the school district level for years 2005-2013.

I drop the top and bottom 1% of school districts according to total education spending per pupil. This allows me to limit sensitivity to outliers in the data. I also drop all school districts with fewer than 100 students, to limit sensitivity to changes in enrollment. This approach is common in the education literature (Gordon (2004), Evans et al. (2017)). The final sample consists of 111,061 district-year observations, covering all 50 states.

Table 2.2 contains summary statistics of the final sample. The columns correspond to quintiles of per-pupil Recovery Act funds received by the district in years 2009-2011. Districts that received more Recovery Act grants tend to have lower enrollment and higher poverty rates. Their education budgets rely more on state and Federal education grants, and less on local contributions. However, total education expenditure does not appear to be correlated to the amount of Recovery Act grants received.

## **2.4 Estimation strategy**

In this section, I describe the identification assumptions and the estimation strategy used to identify the causal impact of increased Federal grants during the Great Recession on state and local district education finance.

### **2.4.1 The relationship of interest**

In order to estimate the impact of increased per-pupil Federal grants, I estimate the following identifying equation:

$$\Delta_{2007} \frac{Y_{ds,t}}{Pupil_{ds,t}} = \beta_0 + \beta_1 \Delta_{2007} \frac{FC_{ds,t}}{Pupil_{ds,t}} + \beta_2 X_{ds,t} + \mu_s + \nu_t + \varepsilon_{ds,t} \quad (2.1)$$

The variable  $Y_{ds,t}$ , represents one of three different measures of education finance: state contributions, district contributions, or total education funds<sup>4</sup> in district  $d$ , located in state  $s$  at time  $t$ . The variable  $FC_{ds,t}$  represents Federal education contributions.  $Pupil_{ds,t}$  is district enrollment, so that the outcome variables,  $Y_{ds,t}/Pupil_{ds,t}$ , and the treatment variable,  $FC_{ds,t}/Pupil_{ds,t}$ , are in per-pupil terms.

Following the approach that is common in the education finance literature (Gordon (2004), Bhalla et al. (2017)), I measure these variables as changes from the last year prior to the beginning of the recession, 2007. This approach allows me to focus my analysis on those changes driven by the ARRA. States also had significant discretion over when stimulus funds were distributed to districts. This is because the Recovery Act funding documentation records when states received Recovery Act funds but does not record when state governments passed on these funds to the constituent districts. As a result, there is a lot of state-level variation in timing: California and Illinois released funds to districts immediately, while other states kept the fund to distribute later in the recession. By taking differences of the outcome variable, I abstract from this timing issue, as well as control for unobserved district-level fixed characteristics.

The estimation equation contains  $\mu_s$ , a state fixed effect, which account for trends in fiscal outcomes that are common to all districts in the state. It also includes  $\nu_t$ , a year fixed effect, which accounts for aggregate (time-series) trends.<sup>5</sup> I also include  $X_{ds,t}$ , which is a vector of time-varying observable school district characteristics, including poverty share, share of english language learners, median household income, and minority share. Doing so allows me to account for changes in the fiscal outcomes that are due simply to demographic changes like race or district incomes. Finally,  $\varepsilon_{ds,t}$  is an error term.

The key parameter of interest is  $\beta_1$ , which represents the effect of a \$1 increase in per-pupil Federal grants on the outcomes of interest. When the outcome is local or state education contributions, then  $\beta_1 = -1$  is evidence of no flypaper effect or full crowd-out, because an additional dollar of per-pupil Federal grants results in either the state or local government reducing their contribution by exactly one dollar. On the other hand, if  $\beta_1 = 0$ , then there is evidence of complete flypaper effect or no crowd-out, because the additional dollar in Federal grants has no impact on either state or local government funding and therefore increases total education revenue dollar for dollar. When the outcome is total

<sup>4</sup>Total education funds is generally equal to the sum of state, district, and Federal education contributions.

<sup>5</sup>Estimates are robust to including a combined state×year fixed effect instead.

contributions, generally  $\beta_{1,total} = \beta_{1,state} + \beta_{1,local} + 1$ .<sup>6</sup> Therefore,  $\beta_1 = 0$  represents no flypaper effect/full crowd-out, while  $\beta_1 = 1$  represents complete flypaper effect/no crowd-out.

A major threat to identification is the potential endogeneity of the amount of stimulus grants received by the district. The  $\beta_1$  estimate can be interpreted as causal only if the increase in Federal grants is exogenous to states' and local districts' education funding decisions that are not accounted for by the other covariates. However, Federal grants are potentially endogenous, either because of state discretion over ARRA grant allocations (which may favor districts that also receive higher state funding), or because funds are allocated competitively (which favors districts that are more likely to have higher spending levels in the first place). Both cases lead to bias which favors finding a positive relationship between Federal grants and state contributions and total revenue, respectively.

## **2.4.2 Instrumental variables**

I address this endogeneity issue with instrumental variable estimation. I define three instruments for the increase in Federal grants due to the implementation of ARRA. Two of these instruments are related to expansions of the two major Federal grant programs, Title 1 grants and IDEA Special Education grants, while one instrument is related to the State Fiscal Stabilization Fund, which was created with the Recovery Act.

### **2.4.2.1 Instruments for expansions of existing programs**

Because Title 1 and IDEA special education grants are allocated according to formulas that were determined prior to the beginning of the Great Recession, the size of these types of grants received by a specific school district is independent of the school district's actions during the recession. The first two instruments are based on the formulas used to determine these two grants.

The first instrument is based on Title 1 grants. The Recovery Act resulted in an additional \$13 billion of Title 1 grants, which roughly doubled the pre-Recession size of the Title 1 program.<sup>7</sup> The rules regarding how Title 1 funds were allocated across districts were unchanged by the Recovery Act.

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<sup>6</sup>This is because total education contributions is the sum of state, local and Federal contributions. The "1" on the right hand side represents the additional \$1 of Federal grants.

<sup>7</sup>The Recovery Act also provided an additional \$0.65 billion for Education Technology State grants, which were created by the ESEA alongside Title 1 grants. Allocations to these programs are discretionary and are not based on formulas, so this amount is excluded from the Title 1 instrument.



I simulated a district's share of the additional \$13 billion in Title 1 grants to be proportional to its share of enrolled children in poverty.<sup>8</sup> That is, the Title 1 instrument is defined as follows:

$$Title1_d = \left( \frac{1}{Pupil_{ds,t}} \right) \frac{Pov_{d,2007}}{Pov_{2007}} \times 13 \text{ billion} \quad (2.2)$$

where  $Pov_{d,2007}$  is the number of children in poverty in 2007, the year before the Recovery Act was implemented.  $Pov_{2007}$  is the total amount of number of children in poverty in 2007.

The second instrument is based on IDEA Special Education grants. IDEA grants are grants to states: each state is allocated an amount equal to the amount it received in 1999. Any appropriated funds over the 1999 amount are then distributed to states according to child population and poverty rates. This formula was developed years before the start of the recession and was unchanged by the passing of the Recovery Act.

I have data on the state-level allocations of additional ARRA IDEA funds. I abstract from the complication of the formula that determines how states distribute IDEA funds, and simulate a districts's share of the IDEA funds available to the state as proportional to its share of the state's enrolled children with special needs. The IDEA instrument is defined as follows:

$$IDEA_d = \left( \frac{1}{Pupil_{ds,t}} \right) \frac{SpecEd_{d,2008}}{SpecEd_{s,2008}} \times IDEA_{s,ARRA} \quad (2.3)$$

where  $SpecEd_{d,2008}$  is the district's population of students with special needs, and  $SpecEd_{s,2008}$  the total number of students with special needs in the state.  $IDEA_{s,ARRA}$  is the state's allocation of IDEA Special Education grants through the Recovery Act, as recorded by the District of Education.

#### 2.4.2.2 Instruments for new programs

The State Fiscal Stabilization Fund ("SFSF") was a sizable new grant program introduced by the Recovery Act. Similar to IDEA grants, states had discretion over how SFSF funds were allocated within the state. As a result, it suffers from the same endogeneity issue that IDEA grants suffer from, and cannot be used directly in a regression without risking significant bias. Unlike IDEA grants, however, SFSF grants were not specifically earmarked for a subpopulation of children served by the state's schools and school districts, so it is natural to use an instrument that is based on a district's share of all state contributions to education in that district's state.

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<sup>8</sup>An alternative specification of this instrument would be to define the district's share of Title 1 funds as proportional to the amount of Title 1 funds it received in the year before the Recession. The main results are not sensitive to this specification.

The SFSF instrument is defined as follows:

$$SFSF_{ds} = \left( \frac{1}{Pupil_{ds,t}} \right) \frac{SF_{d,2008}}{SF_{s,2008}} \times SFSF_{s,ARRA} \quad (2.4)$$

where  $SF_{d,2008}$  the amount of state funds received by the district in 2008, and  $SF_{s,2008}$  is the total amount of state funds received by all districts in the state.  $SFSF_{s,ARRA}$  is the state's share of all SFSF funds.

### 2.4.3 Two-stage least squares estimation

The instruments for IDEA and Title 1 are undefined when poverty (Title 1) or special education (IDEA) information is not available for the district. By construction, the only time the the SFSF instrument is undefined is when districts did not receive state funds in 2007. I limit my analysis to districts for which all instruments are defined. I use the three instruments described in subsection 4.2 on the following 2SLS equation:

$$\Delta_{2007}FC_{ds,t} = \alpha_0 + \alpha_1 Title1_{ds,t} + \alpha_2 IDEA_{ds,t} + \alpha_3 SFSF_{ds,t} + \delta_1 X_{ds,t} + \mu_{1,s} + \nu_{1,t} + \varepsilon_{1,dst} \quad (2.5)$$

$$\Delta_{2007}Y_{ds,t} = \beta_0 + \beta_1 \widehat{\Delta_{2007}FC_{ds,t}} + \delta_2 X_{ds,t} + \mu_{2,s} + \nu_{2,t} + \varepsilon_{2,dst} \quad (2.6)$$

Consider the first-stage estimation equation, (2.5). The left-hand side variable,  $\Delta_{2007}FC_{ds,t}$ , is the potentially endogenous treatment variable in (3.2). I regress the change in Federal education contributions on the three instruments plus state and year-specific fixed effects. I then use the predicted change in Federal education contributions in the second stage, (2.6), to calculate the unbiased causal effect of increased Federal contributions on the outcome of interest.

This 2SLS approach allows me address the identification threats mentioned in subsection 4.1, because the instruments are “fixed” using pre-recession information, and are plausibly exogenous to state and local districts’ fiscal decisions.<sup>9</sup>

## 2.5 Results

### 2.5.1 Effect of Federal stimulus funds on education finance

I analyze the effect of expanded federal grants on state and local education finance using instrumental variable analysis.

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<sup>9</sup>I formally test this statement in the Results section of this paper.

### 2.5.1.1 The first stage relationship

In this subsection, I test whether the instruments described in subsection 2.4.2 are valid instruments and are relevant to the time period of interest. In particular, I test two hypotheses. First, relevance: the instruments must be related to changes in Federal education revenue beginning in 2009, when the first Recovery Act funds were disbursed. Furthermore, as a falsification test, the instruments should not have any predictive power over changes in Federal education revenue prior to 2008.

Consider the cross-section coefficient estimates of  $\alpha$  in the following regression:

$$\Delta_{2007}FC_{ds} = \alpha_0 + \alpha_1 Title1_{ds,t} + \alpha_2 IDEA_{ds,t} + \alpha_3 SFSF_{ds,t} + \delta X_{ds} + \mu_s + \varepsilon_{ds}, \quad (2.7)$$

where  $FC_{ds}$  is the endogenous variable, Federal contributions to education received by the district. The right hand side of the equation includes the three instruments defined in the earlier section.

When the instruments are predictive of the dependent variable, the  $\alpha$  estimate should be statistically significant, and not otherwise. Since the Recovery Act funds were only disbursed beginning in 2009, I expect that estimates for years 2008 and earlier will be insignificant, and significant for years past 2009. Because the dependent variable is defined to be changes from 2007, the 2007 estimate is 0 by construction.

The  $\alpha$  estimates are presented in Figure 2.3, where the lines through each point represent the 95% confidence interval around these estimates. As predicted, all the instruments have no explanatory power prior to 2008. The estimates are positive beginning in 2009, but it is not statistically significant for the IDEA and SFSF instruments, while it is marginally significant for the Title 1 instrument.

Between 2009 and 2011, all the estimates are statistically significantly different from 0, which indicates that the instruments are explaining at least some part of the observed changes in Federal contributions received by the district. This coincides with when the ARRA funds were distributed to districts. The Title 1 and IDEA instruments continue to have explanatory power after 2011, but the SFSF instrument does not.

Table 2.3 summarizes the regression results for (2.5), the first stage equation, for the years 2009-2011. To differentiate the effect of each instrument on the endogenous variable, I show five specifications of the first stage containing different combinations of the three program instruments. The first three columns include one program instrument, to capture the impact of each of the instruments on the endogenous variable, the change in Federal grants received by the district, in isolation.

Column 4 contains only the instruments that are associated with pre-existing Federal

grant programs. Column 5 contains all three program instruments, and is my preferred specification. The first stage has an F-statistic of 26.42, so there are no concerns of finite sample bias.

### 2.5.1.2 Second-stage estimates

Table 2.4 describes the effects of the increased Federal grants during the Great Recession on district-level fiscal outcomes. I present three models, each corresponding to a different outcome variable: local revenue, state revenue, and total education revenue respectively. The first row contains the OLS estimates, and the second row contains the two-stage least squares estimates. Standard errors are in parentheses, and clustered at the district level. I focus my discussion on the IV (“2SLS”) estimates.

Consider the first column, where local revenue is the outcome under consideration. The OLS and IV estimates both agree that the additional Federal grants resulted in higher local education contributions. That is, an additional dollar of Federal grants induced the district to contribute \$0.09 and \$0.46 more toward education (“crowd-in”) for the OLS and 2SLS models, respectively. Furthermore, the magnitude of the OLS estimate is smaller than the IV estimate, which is consistent with bias resulting from Recovery Act funds being targeted to districts that have lower ability to raise local funding.

The second column has state revenue as the outcome variable. The OLS estimate is insignificant, while the IV estimate implies that an additional dollar of Federal grants resulted in \$0.41 less state revenue, but the estimate is also not statistically significant. This is clear evidence of crowding out, since the state contributed less to education when Federal grants increased. The difference between the OLS and IV estimates is consistent with districts that rely less on state contributions receiving fewer Recovery Act funds.

Finally, the third column has total revenues as the outcome variable. The OLS and 2SLS estimates are similar and indistinguishable from 1. Because  $\beta_{1,total} = \beta_{1,state} + \beta_{1,local} + 1$ , this indicates that there is little crowd-out at the level of total revenues. It appears that the crowding-in of local revenues is almost exactly offset by the crowding-out of state revenues. Ultimately, there is significant flypaper effect, and these additional Federal funds are not crowded-out at the total revenue level. Indeed, there is evidence of minor crowding-in of about \$0.04 for every dollar granted, but this effect is not statistically significant.

The different effects of additional Federal grants at the state or local level is likely due to a variety of reasons, one of which is the fact that state and local education revenues are often earmarked for different types of school expenditures. Consider, for example, the case when local education revenue is used to fund instruction and teacher’s salaries.

If a school district receives an additional \$100 per student education grant that is spent to offer new classes or on a new building, then it may be necessary for the local district to pay for additional teachers to teach these classes or for utilities for the new building. This additional expense would appear as crowding-in Federal revenue. On the other hand, if state spending has fewer such restrictions, then it is less likely for such crowding-in patterns to appear, and I would be more likely to observe the standard crowding-out of Federal funds.

### 2.5.2 Decomposition of results: existing vs. new programs

To explore earmarking as a potential explanation of the causal estimates calculated in the previous subsection, I consider a categorization of the Recovery Act funds. Recall that the Recovery Act funds were channeled through either expansions of existing grant programs (Title 1 grants and IDEA special education grants) or through a new program created by the Recovery Act (SFSF). Title 1 and IDEA special education grants are for specific purposes—to support students in poverty or need special education accommodations. On the other hand, the SFSF was created by the Recovery Act specifically to help stabilize state and local budgets to ensure that spending on education would not drop drastically during the Great Recession.

Because Title 1 and IDEA special education grant programs are more narrowly targeted, I expect to observe that expansions of these programs will tend to stick. The SFSF, which has less restrictions, is expected to be more likely to get crowded out. I test whether the program through which the additional Recovery Act funds were distributed matters for the rate of crowd-out. Consider the following 2SLS estimation:

$$\Delta_{2007}OldGrants_{ds,t} = \alpha_{old} + \alpha_{1old}Title1_{ds,t} + \alpha_{2old}IDEA_{ds,t} + \alpha_{3old}SFSF_{ds,t} + \delta_{1old}X_{ds,t} + \mu_{old,s} + \nu_{old,t} + \varepsilon_{old,ds,t} \quad (2.8)$$

$$\Delta_{2007}NewGrants_{ds,t} = \alpha_{new} + \alpha_{1new}Title1_{ds,t} + \alpha_{2new}IDEA_{ds,t} + \alpha_{3new}SFSF_{ds,t} + \delta_{1new}X_{ds,t} + \mu_{new,s} + \nu_{new,t} + \varepsilon_{new,ds,t} \quad (2.9)$$

$$\Delta_{2007}Y_{ds,t} = \beta_0 + \beta_{old}\widehat{\Delta_{2007}OldGrants_{ds,t}} + \beta_{new}\widehat{\Delta_{2007}NewGrants_{ds,t}} + \delta_2X_{ds,t} + \mu_{2,s} + \nu_{2,t} + \varepsilon_{2,ds,t} \quad (2.10)$$

There are two endogenous variables in the above equations. The first endogenous variable,  $OldGrants_{ds,t}$ , represents existing Federal grants, which is defined as the sum

of the district's actual receipt of Title 1 and Idea Special Ed grants in year  $t$  ("existing grants", or "old grants"). The second endogenous variable,  $NewGrants_{ds,t}$  is defined as the difference between the change in total Federal grants and  $V_{ds,t}$  ("new grants"). I regress these two endogenous variables on the three program instruments.

Because of how the endogenous variables are defined, mathematically the estimates of the effect of all grants,  $\beta_1$  in equation (2.6), will lie somewhere between  $\beta_{old}$  and  $\beta_{new}$ . To illustrate this, consider the following example, where the outcome variable is total education revenue. A school district receives \$100 per student in additional Federal grants, \$25 of which is through Title 1 or IDEA special education, and the remaining \$75 from other grants. Then the effect of the additional \$100 in Federal grants on the school district's own education effort will be a weighted average of the effect of old and new grants:

$$\beta_1 = 0.25 \times \beta_{old} + 0.75 \times \beta_{new}$$

### 2.5.2.1 First-stage estimates

In this subsection, I perform a similar exercise to that in subsection 2.5.1.1, and explore how the instruments relate to the endogenous variables. Figure 2.4 contains cross-section estimates of  $\alpha$  in equation (2.8) by year, so the endogenous variable under consideration is the change in the total Title 1 and IDEA Special Education grants received by the school district relative to 2007 ("existing grants"). Because 2007 is the basis year, the estimate for 2007 is zero by construction. There appears to be a secular trend in the relationship between all three program instruments and the endogenous variable prior to the recession, as evidenced by the positive estimate for 2005. This is likely due to the fact that the formulas for awarding Title 1 and IDEA grants are unchanged during the analysis period. However, the bias is fairly small: maximum size is about .15. The most powerful instrument for this endogenous variable is the Title 1 instrument, followed by the IDEA instrument. These two instruments together explain about \$0.85 of every dollar granted. The Stabilization Fund instrument has much lower explanatory power, and in fact has no explanatory power outside of 2010, where it explains about \$0.05, however the confidence intervals are large.

Figure 2.5 contains cross-section estimates of  $\alpha$  in equation (2.9) by year, so the endogenous variable under consideration is the change in Federal grants received by the school district relative to 2007 that are not accounted for by the Title 1 and IDEA Special Education grants ("new grants"). Similar to Figure 2.4, the coefficient for 2007 is 0 by construction. All three instruments have no predictive power over the receipt on new grants prior to 2009 and after 2011, which coincides with when the Recovery Act funds were distributed. The Stabilization Fund and Title 1 instruments have the most explana-

tory power in 2009-2011, combining to explain approximately \$0.80 per dollar granted in 2010. The IDEA Special Education instrument explains some of the grants, but the confidence intervals are large so it is difficult to conclude anything about its year-on-year impact.

Table 2.5 contains the first stage regression results. Consistent with the earlier two figures, the Title 1 and IDEA instruments have the most explanatory power over existing grants (that is, the sum of actual Title 1 and IDEA Special Education grants received by the district), while the Stabilization Fund instrument has the most explanatory power over new grants (that is, Federal grants other than the existing grants). The F-statistics for existing and new grants are 26.06 and 25.61, respectively, so there are no concerns of finite sample bias.

### 2.5.2.2 Second-stage estimates

Table 2.6 reports the second-stage decomposition estimates of equation 2.10. Each column is a unique regression, where the figures in the first and second row are  $\beta_{old}$  and  $\beta_{new}$  respectively. There are three sets of results, each corresponding to a different outcome.

I now focus on the IV estimates in my discussion. First, I discuss the effects of expanding existing grants like Title 1 and IDEA Special Education grants. These are reported in the first row of Table 2.6. I find some evidence that expansions of both existing and new grants crowd in local and state education contributions. However, these estimates are not statistically significantly different from zero. I also find that an additional dollar of Title 1 or IDEA Special Education grants result in about \$1.65 more total education revenue. This is consistent with a full flypaper effect, and with a 95% confidence allows a crowd-out effect of at most 40%.

I attribute this finding to the fact that Title 1 and IDEA Special Education grants are established Federal grant programs and it is likely that state or local district policy-makers have minimal influence over the distribution of these grants. Furthermore, I observe some evidence of crowding-in of funds at both the state and local district level, consistent with the lack of flexibility and the need for supplementary spending on the behalf of the state and local school district to support Title 1 and IDEA initiatives.

Second, I discuss the effects of expanding new grants. Unlike Title 1 and IDEA special education, these new grants, of which the State Fiscal Stabilization Fund is a significant portion, are not targeted towards specific sub-populations of students. States receive these grants and have the flexibility to distribute them to their constituent school districts. Furthermore, after receiving these grants from the parent state government, school districts are not required to spend the grants on specific programs. Hence, these grants are very

close to “lump sum” grants.

The other key difference between these new grants and Title 1 and IDEA special education grants is that these new grants are not just new, they were also explicitly temporary. The Recovery Act allocated \$48.3 billion through the SFSF, and states were mandated to give these funds to school districts within two years. Title 1 and IDEA special education grants, on the other hand, were historically Federal grant programs and expected to continue after these two years.

The  $\beta_{new}$  estimates are reported in the second row of Table 2.6. Of note here is the significant difference between the OLS and 2SLS estimates in the regressions for State Revenue and Total Revenue. When the dependent variable is State Revenue, as in columns (3) and (4), the OLS estimate is insignificant while the 2SLS estimate is statistically significantly negative. When the dependent variable is Total Revenue, I find that the OLS estimate for new grants is statistically significant and positive, but the 2SLS estimate is not statistically different from zero. A reason why we observe this pattern is that unpredictable portions of the Recovery Act funds are going to districts that would have had unusually high education spending levels anyway during that time period. Hence, using the OLS method leads me to estimate a positive relationship between the additional new grants and Total Revenue. However, using an IV approach allows me to reduce this bias, and allows me to capture the true relationship between these variables.

I find that an additional dollar of new grants has no impact on local contributions. This effect is precisely estimated, and I am able to conclude that expansions of these new grants do not crowd-out local contributions. On the other hand, I also find that state governments reduce their education contributions by \$1.12 for every additional dollar of new grants. This indicates that states completely crowd out new Federal grants. Finally, I find that the additional dollar of new grants is completely offset by the decrease in state funds. That is, the new grants acted to relieve state governments but allowed no tax relief to local districts. This finding is consistent with Evans et al. (2017), who in their study of the State Fiscal Stabilization Fund also found these grants completely crowded-out.

## 2.6 Conclusion

In this paper, I study the effect of expanded Federal education contributions during the period of the Great Recession on school district-level K-12 education finance. Through the ARRA, Federal education revenue increased by almost 50%, from approximately \$850 to \$1300 per pupil in the average school district. The ARRA funds were allocated to districts in one of two ways: expanding existing Federal education programs like Title 1 or IDEA Spe-



cial Education grants, or through a new program, the State Fiscal Stabilization Fund. This natural experiment allows me to study whether the anti-recession measure introduced by the government with the Recovery Act was able to achieve the goal of stabilizing education budgets in school districts across the US.

My paper has two major contributions. First, I analyze a temporary increase in Federal education contributions, in contrast to earlier papers like Gordon (2004) who analyzed permanent increases of Federal contributions through the introduction of new programs. I am also able to shed light on the flypaper effect, a long-studied empirical puzzle.

My results suggest that the program through which the ARRA funds were distributed had a huge impact on the flypaper effect of these funds. Funds channeled through expansions of existing grants were not crowded-out at the state or local level, resulting in a dollar for dollar increase in district-level total education revenue. On the other hand, funds that were channeled through the SFSF were completely crowded out at the state level, so that district-level total education revenue was unchanged.

## 2.7 Figures

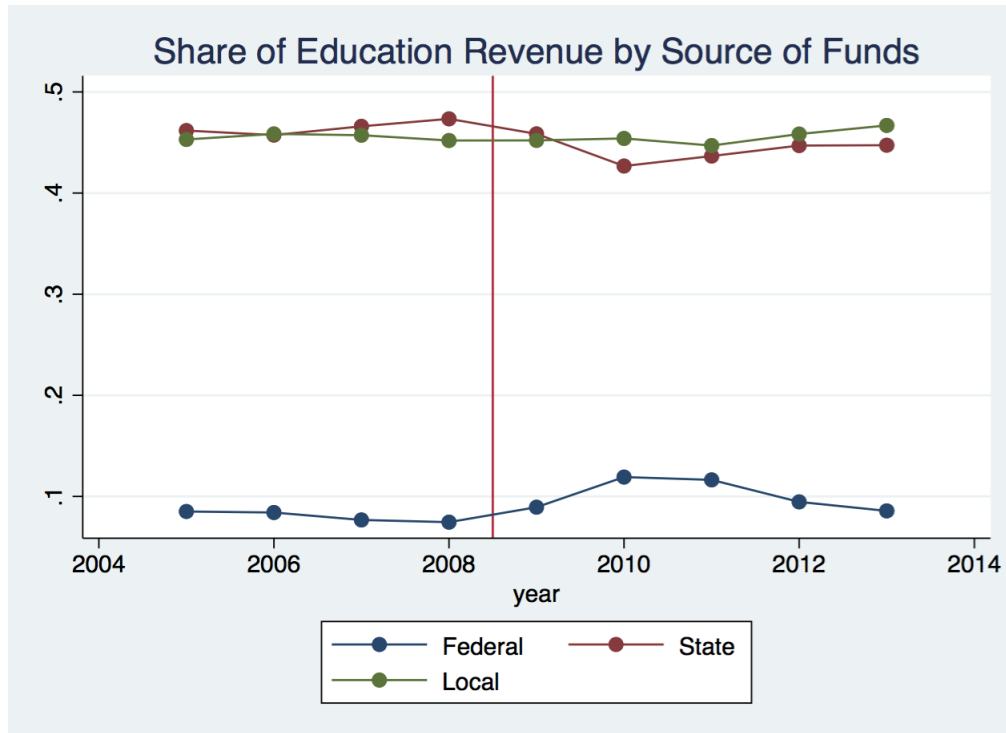


Figure 2.1: Time series of the share of K-12 education revenues by source

This figure shows that approximately 45% of total K-12 education funding is raised by state governments, and a roughly equal amount is from local governments, while about 9% comes from the Federal government. These shares have remained fairly constant over time, outside of an increase in Federal funds beginning in the Great Recession, marked by the vertical red line.

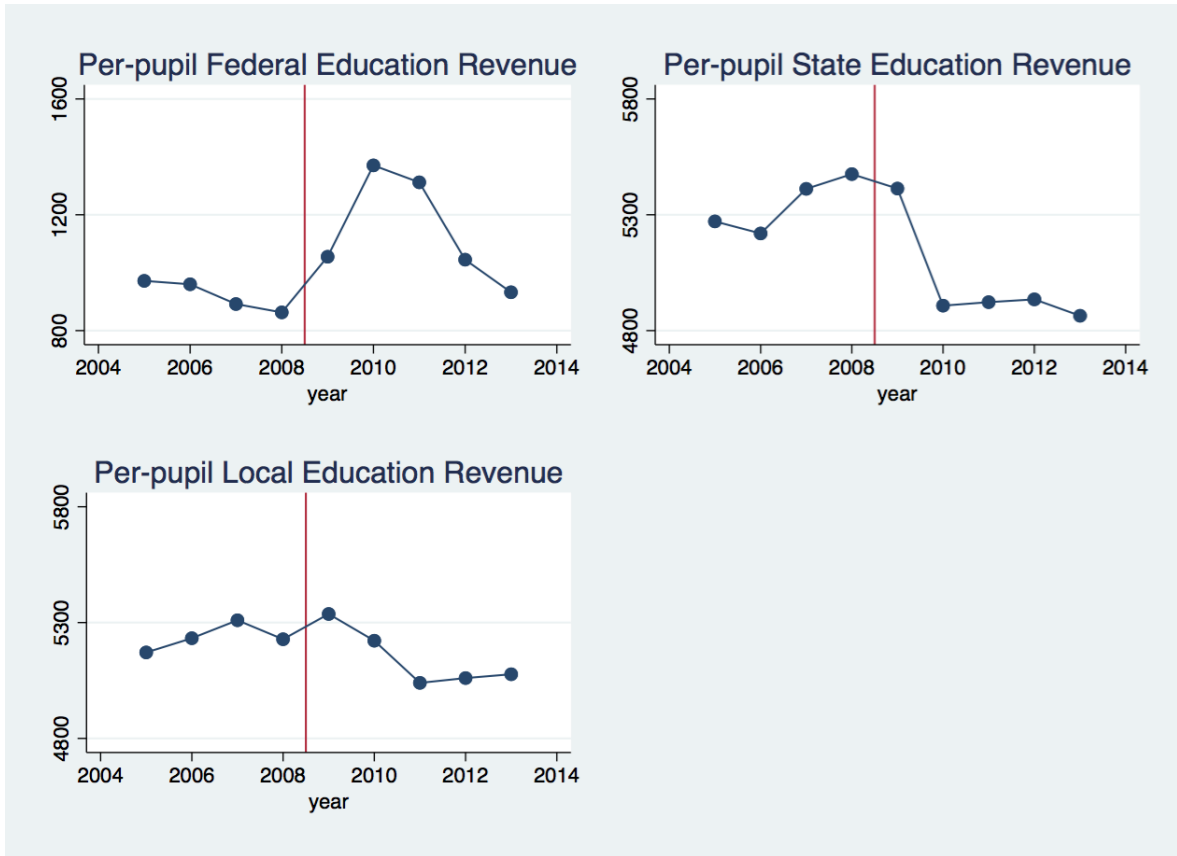


Figure 2.2: Trends in per-pupil revenue during the Great Recession

This figure shows how education revenues changed around the time of the Great Recession, marked by the vertical red line. All values are in per-pupil terms and in 2009 dollars. Federal per-pupil revenue increases sharply after 2008, and stays high for a few years before decreasing back to its pre-2008 level. State per-pupil education revenues decrease after 2008 and remain low in the years following. Local per-pupil revenues are relatively unchanged compared to Federal and state revenues.

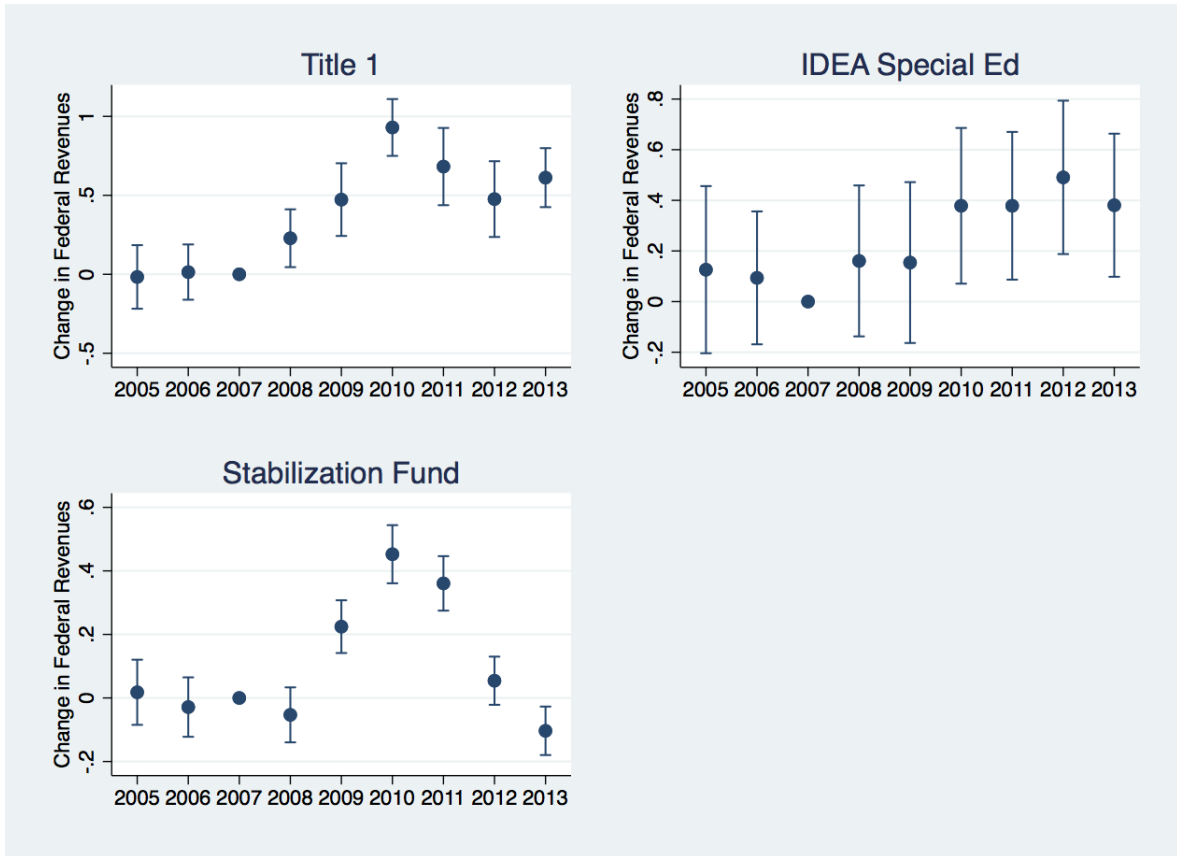


Figure 2.3: Effect of program instruments on Federal grants by year

Each point is the cross-section  $\alpha$  estimate of the effect of each of the instruments on the endogenous y-variable, described by equation (2.7). The variable on the y-axis represents the change in per-pupil Federal grants received by the district relative to 2007. By construction, the  $\alpha$  estimates for 2007 is 0. The instruments have no effect prior to 2009, which makes sense because the ARRA was only passed in 2009. After 2009 to 2013, the instruments have predictive power.

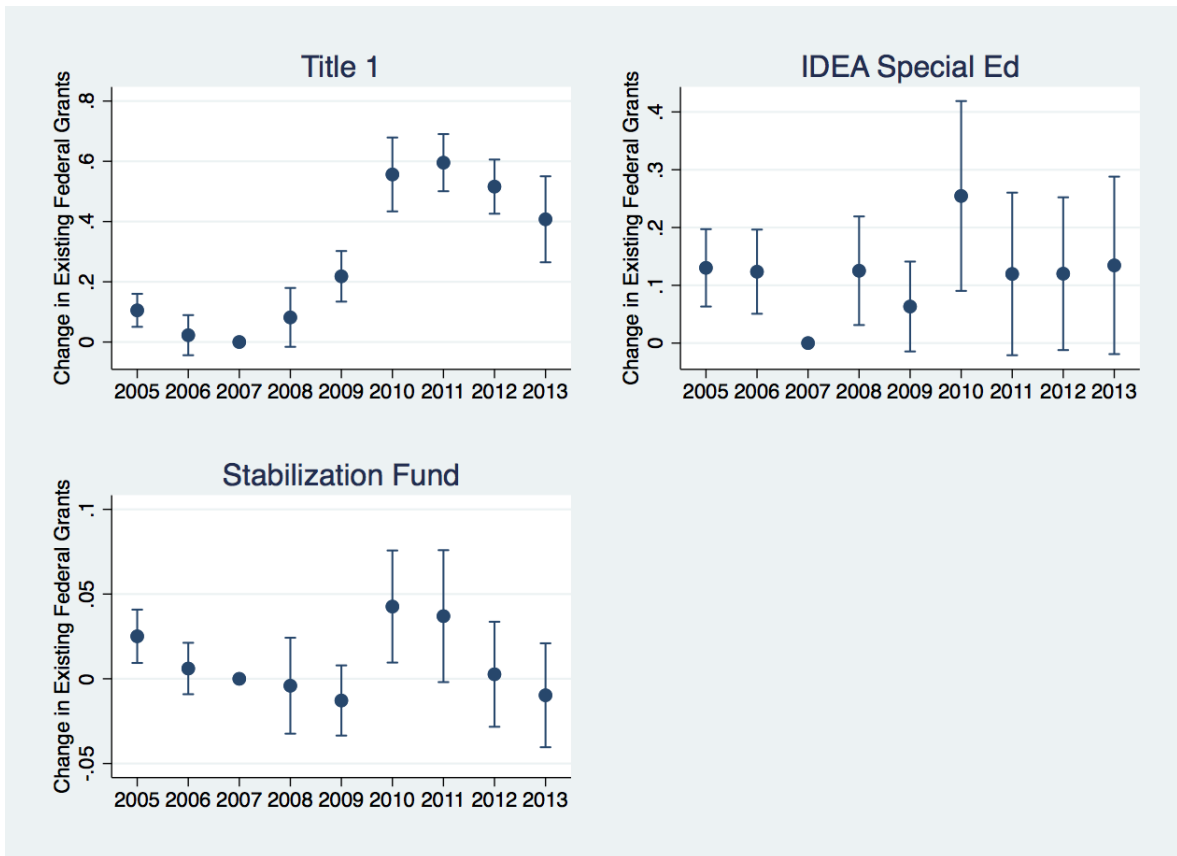


Figure 2.4: Effect of program instruments on existing (old) Federal grants by year

Each point is the cross-section  $\alpha$  estimate of the effect of each of the instruments on the endogenous y-variable, described by equation (2.8). The variable on the y-axis represents the change in per-pupil Title 1 and IDEA Special Education grants (“existing grants”) received by the district relative to 2007. By construction, the  $\alpha$  estimate for 2007 is 0. There appears to be a secular trend prior to the implementation of the Recovery Act. The Title 1 and IDEA instruments explain about \$0.80 per dollar granted, while the Stabilization Fund instrument has no explanatory power outside of 2010, where it explains about \$0.05, but the confidence intervals are large.

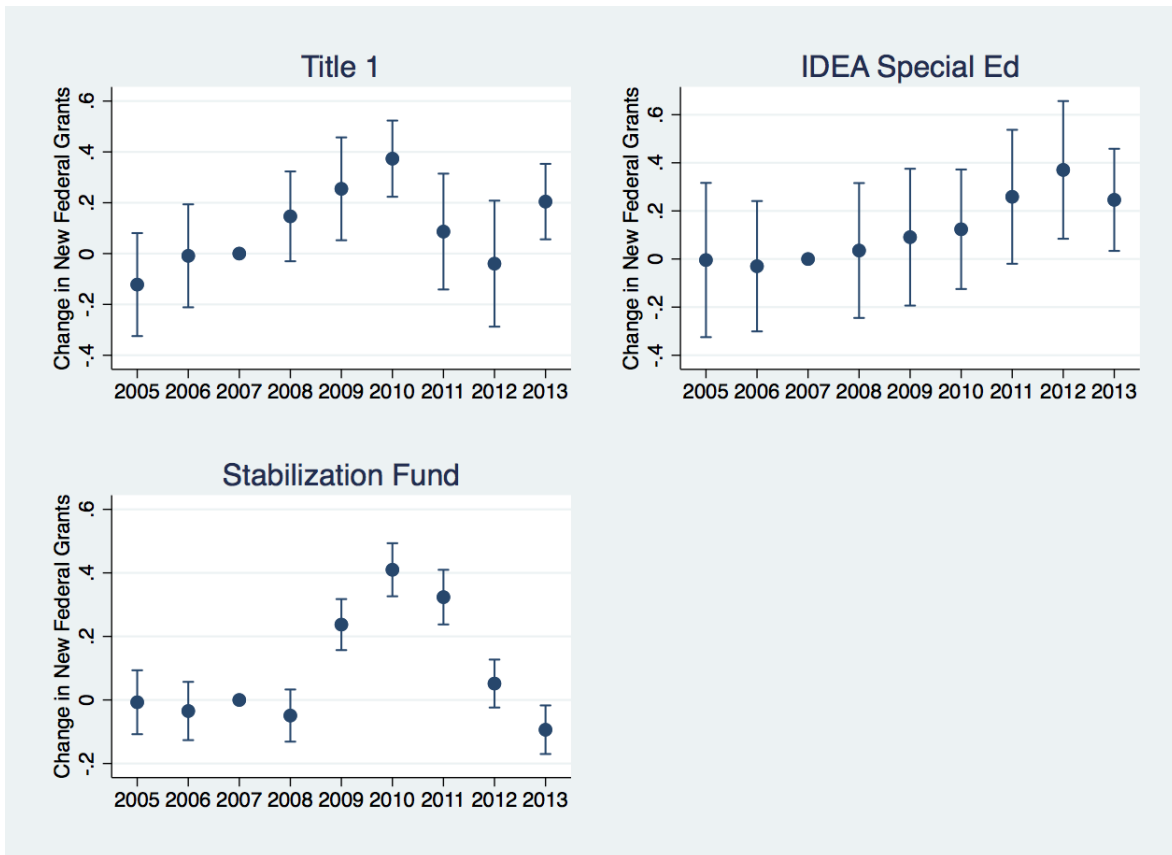


Figure 2.5: Effect of program instruments on new Federal grants by year

Each point is the cross-section  $\alpha$  estimate of the effect of each of the instruments on the endogenous y-variable, described by equation (2.9). The variable on the y-axis represents the change in per-pupil Federal grants received by the district relative to 2007 that are not accounted for by Title 1 or IDEA Special Education grants (“new grants”). By construction, the  $\alpha$  estimate for 2007 is 0. The instruments have no explanatory power over the size of new grants prior to 2009. In 2009 and 2010, the Title 1 and Stabilization Fund instruments both explain about \$0.30 per dollar granted. The IDEA instrument is weaker, but this may have to do with collinearity.

## 2.8 Tables

Table 2.1: Allocation of Recovery Act education funds

Program	Amount
<b>Title 1 grants to local education agencies</b> (includes targeted, incentive, and school improvement grants)	\$13 billion
<b>IDEA special education grants</b>	\$12.2 billion
<b>State Fiscal Stabilization Fund</b>	\$53.6 billion
<b>Other education grants</b> (including Federal Pell grants)	\$19.4 billion

The table above shows the amount of Recovery Act education funds that went to each of the three largest Recovery Act programs.

Table 2.2: Summary statistics by quintile of recovery grants received

	(1) Lowest Quintile	(2)	(3)	(4)	(5) Highest Quintile
Federal contributions	762.4 (466.2)	1023.4 (639.0)	1233.5 (600.4)	1492.1 (886.1)	2141.0 (1702.7)
Poverty rate	0.0992 (0.0590)	0.140 (0.0663)	0.177 (0.0709)	0.210 (0.0801)	0.260 (0.101)
Share Special Ed	0.120 (0.0347)	0.128 (0.0370)	0.134 (0.0434)	0.141 (0.0506)	0.154 (0.0577)
Share English Language Learners	0.0413 (0.0757)	0.0411 (0.0826)	0.0415 (0.0886)	0.0405 (0.0928)	0.0395 (0.0941)
State contributions	3527.2 (1676.5)	5066.9 (1676.0)	5573.2 (1617.3)	5963.0 (1779.8)	6954.4 (2523.0)
Local contributions	8550.2 (4421.0)	5364.0 (3053.6)	4462.7 (2730.0)	4000.7 (2462.5)	3907.5 (2658.8)
Total expenditure	11391.7 (3379.0)	10173.5 (2406.0)	10158.9 (2372.3)	10396.7 (2422.8)	11815.5 (3396.8)
Enrollment	5264.1 (13005.3)	4947.5 (14210.7)	3963.9 (10797.8)	3137.4 (9187.1)	2773.4 (17929.4)
Observations	6258	6257	6258	6257	6257

This table contains summary statistics of the final sample, and the unit of observation is the school district. School districts are grouped into quintiles of the amount of Recovery Act funds received. High grant districts received more state and Federal education contributions, and rely less on local grants. These districts also tend to have lower enrollments and higher poverty rates. There is no obvious relationship between total education revenue and receipt of Recovery Act funds. All fiscal variables are in per-pupil terms, and denominated in 2009 dollars.



Table 2.3: First stage regressions

	(1)	(2)	(3)	(4)	(5)
	Federal grants	Federal grants	Federal grants	Federal grants	Federal grants
Title 1	0.704*** (0.0780)			0.629*** (0.0812)	0.446*** (0.0868)
IDEA Special Ed		0.849*** (0.146)		0.488*** (0.144)	0.278* (0.136)
Stabilization fund			0.439*** (0.0406)		0.329*** (0.0417)
Observations	31287	31287	31287	31287	31287
District and Time FEs	X	X	X	X	X
Demographic Controls	X	X	X	X	X
F	28.14	20.47	23.81	25.91	26.42

Standard errors in parentheses

\*  $p < 0.05$ , \*\*  $p < 0.01$ , \*\*\*  $p < 0.001$ 

This table contains coefficient estimates of the first stage regression equation (2.5), using the instruments described in Section 4. Demographic controls include including poverty share, share of English language learners, median household income, and minority share. The unit of observation is the school district, and standard errors are clustered at the school district level. All fiscal variables are in per-pupil terms and denominated in 2009 dollars. The first column shows the effect of the Title 1 instrument on the change in Federal grants, when it is the only instrument used. Similarly column 2 and 3 show the effect of the IDEA instrument and the SFSF instrument, respectively. Column 4 is the effect of both permanent program instruments, while column 5 contains all instruments. My preferred specification is the one in column 5. All instruments appear to be powerful, with F-statistics larger than 20.

Table 2.4: Effect of (all) Federal grants

	(1) Local Revenue	(2) State Revenue	(3) Total Revenue
OLS	0.0910*** (0.0208)	0.00252 (0.0258)	1.094*** (0.0373)
2SLS	0.458*** (0.129)	-0.412*** (0.185)	1.046*** (0.172)
Observations	31287	31287	31287
District and Time FEs	X	X	X
Demographic Controls	X	X	X

Standard errors in parentheses

\*  $p < 0.05$ , \*\*  $p < 0.01$ , \*\*\*  $p < 0.001$ 

This is from the second stage regression equation (2.6). Demographic controls include including poverty share, share of English language learners, median household income, and minority share. The unit of observation is the school district, and standard errors are clustered at the school district level. All fiscal variables are in per-pupil terms and denominated in 2009 dollars. Each cell represents a distinct regression. The dependent variable is indicated at the top of the column, and the rows correspond to the OLS and two-stage least squares estimates, respectively.

Table 2.5: First stage estimates of decomposition

	(1) Existing Grants	(2) New Grants
Title 1	0.356*** (0.0378)	0.0904 (0.0872)
IDEA Special Ed	0.170** (0.0575)	0.108 (0.128)
Stabilization Fund	0.0217 (0.0120)	0.307*** (0.0416)
Observations	31287	31287
District and Time FEs	X	X
Demographic Controls	X	X
F	26.06	25.61

Standard errors in parentheses

\*  $p < 0.05$ , \*\*  $p < 0.01$ , \*\*\*  $p < 0.001$ 

This table contains coefficient estimates of the first stage regression, when there are two endogenous variables, existing (old) and new grants. Demographic controls include including poverty share, share of English language learners, median household income, and minority share. The unit of observation is the school district, and standard errors are clustered at the school district level. All fiscal variables are in per-pupil terms and denominated in 2009 dollars. The first column shows the effect of all three instruments on the change in the receipt of existing grants, defined as the sum of Title 1 and IDEA grants. Only the Title 1 and IDEA instruments have predictive power over this variable. The second column shows the effect of all three instruments on the change in new grants, defined as all Federal grants that are not accounted for by Title 1 or IDEA grants. For this variable, only the SFSF instrument has predictive power.

Table 2.6: Second stage estimates of decomposition

	Local revenue		State revenue		Total revenue	
	(1) OLS	(2) 2SLS	(3) OLS	(4) 2SLS	(5) OLS	(6) 2SLS
Existing Grants	0.256*** (0.0635)	0.521 (0.405)	0.343*** (0.0546)	0.127 (0.173)	1.599*** (0.0842)	1.647*** (0.527)
New Grants	0.0688*** (0.0184)	0.057 (0.426)	-0.0432 (0.0254)	-1.118*** (0.471)	1.026*** (0.0337)	-0.061 (0.432)
Observations	31287	31287	31287	31287	31287	31287
District and Time FEs	X	X	X	X	X	X
Demographic Controls	X	X	X	X	X	X

Standard errors in parentheses

\*  $p < 0.05$ , \*\*  $p < 0.01$ , \*\*\*  $p < 0.001$ 

This is from the second stage regression. Demographic controls include including poverty share, share of English language learners, median household income, and minority share. The unit of observation is the school district, and standard errors are clustered at the school district level. All fiscal variables are in per-pupil terms and denominated in 2009 dollars. Each column is a distinct regression, which are grouped by the dependent variable in the regression. I report both OLS and 2SLS estimates for each dependent variable.

## CHAPTER III

# State Finance Systems and Crowding-out by State Contributions to Education

### 3.1 Introduction

In this paper, I investigate the crowding out of increased state education contributions on total education spending<sup>1</sup> at the school district level. I explore the extent to which this effect depends on the properties of the state finance system in the district's state. Specifically, I use an event-study framework to analyze year-on-year changes in state contributions to a district and the resulting changes in the district's education effort for different state finance system properties.

In the United States, the responsibility of funding K-12 public education falls primarily to state and local governments, and on average, districts receive about the same amount of funds from the state government and from the district's own tax effort. Together, these two sources of funds provide 90% of the average district's K-12 budget, with the remaining 10% coming from Federal sources.<sup>2</sup>

Despite the equality of state and local contributions at the aggregate level, a particular district's reliance on state and local funds is highly variable across states. Consider figure 3.2, which shows the variation in per-pupil state education revenue for the sample districts for Fiscal Year 2012. At the low end, school districts in Utah received \$6,432 per pupil on average in state aid, but school district in New York received \$19,529.<sup>3</sup>

This variation in contributions is driven by differences in state education finance systems, which describes the mechanism through which education revenues are raised and

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<sup>1</sup>In my analysis, total contributions are the same as total spending, and I use these terms interchangeably. This is because in my primary dataset, the F-33 LEA Finance Survey, school districts report their spending and the source of their funds for the fiscal year. For the school districts in the sample, the sum of funds from all sources is equal to total spending.

<sup>2</sup>National Center of Education Statistics ("NCES") Digest of Education Statistics.

<sup>3</sup>NCES Revenues and Expenditures for Public Elementary and Secondary Education, Fiscal Year 2012.

how these funds are shared between school districts within a state. A state finance system is a set of rules that describe how states and local school districts share the responsibility for funding K-12 education. Generally, state governments are responsible for designing the state education finance system and choosing the properties that characterize them. Local school districts have no authority to select these on their own.

I argue that the design of state finance systems has significant implications on the extent of crowding-out of education funds by state education contributions, and therefore, significant fiscal policy implications. This paper relates to the literature on school finance reform and spending (Manwaring and Sheffrin (1997), Murray et al. (1998), Hoxby (2001), Card and Payne (2002), and Downes and Shah (2006)), but takes an alternative approach where school finance systems are characterized by their properties. In this framework, school finance reform occurs when finance systems add or remove properties from their existing state finance system.

This paper has two key contributions. First, I establish the relationship between properties of the state education finance system and the level of crowding out of education funds by state contributions. Second, I show that the different crowd-out rates implied by these properties explain why increased state involvement can lead to both increased and decreased total spending in different school districts.

The rest of the paper is organized as follows. Section 3.2 provides a short overview of the development of state finance systems. In section 3.3 I discuss the characterization of state finance systems according to their properties. Section 3.4 describes the data used in this analysis. In section 3.5 I discuss my identification strategy. In section 3.6 I describe my findings and discuss results. Section 3.7 concludes.

## **3.2 A brief history of state finance systems and reforms**

Prior to 1970, funds for education were primarily raised at the local district level through property taxes, and as a result the amount of funds available to districts was heavily dependent on local property values. This meant that areas with high property values consistently had more money to spend relative to areas with low property values, leading to large within-state differences in per-pupil spending.

Since 1970, states have reformed their education finance systems to move to more across-district redistributive education grants where the state takes on some responsibility for education funding.<sup>4</sup> Some of these movements have been the result of state supreme

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<sup>4</sup>This started with the landmark *Serrano v. Priest* (“*Serrano*”) decision, 487 P.2d 1241 (Cal. 1971), which concerned the constitutionality of the large spending disparities between California school districts.

courts have overturning school finance systems(Jackson et al. (2015)), and some the result of state undergone legislative reform to change how schools are funded. A stated goal of many state finance reforms is reducing inequality of education spending within the state, and common theme that emerges from the literature is that when state finance systems are reformed, total spending changes. However, evidence on whether these reforms have led to increases in education spending is mixed. While these reforms change the relative size of state education contributions within the state, they do not necessarily lead to corresponding changes in total education contributions, because local districts can reduce local effort in response to increased state aid. That is, if local contributions decrease by more than the increase in state contributions, the ultimate outcome is lower overall education funds.

Several papers find that increased state involvement leads to higher total spending. Murray et al. (1998) find that court-ordered education finance reforms that led to more state involvement between 1971 and 1996 have led to decreases in inequality by raising spending in the poorest districts and leaving the richest districts unchanged. Baicker and Gordon (2006) show that school finance reforms between 1980 and 2000 have largely led to higher spending per pupil and less inequality across the state.

Other papers find that increased state contributions leads to lower total spending. Fernandez and Rogerson (1998) show that when California moved to a pure state funding formula in the 1970s, education spending became more equal across districts but overall spending dropped 10-15%. Guryan (2001) uses the passing of the Massachusetts Education Reform Act in 1993 as a natural experiment to analyze how extending state control of education funding affects total per-pupil expenditures. He finds that an additional dollar of state government education spending only increases total per-pupil expenditure by only \$0.50 - \$0.75. Similarly, Card and Payne (2002) find that school finance reforms lead to more equal total per-pupil expenditure within states. They calculate that a \$1 dollar increase in state aid to districts resulted only in a \$0.50-\$0.65 increase in total district spending.

Later papers show a more nuanced result, that reforms that emphasize equalization may result in lower total spending (“leveling down”) or higher total spending (“leveling up”) even as spending across districts within a state becomes more equal. Hoxby (2001) argues that different types of education finance systems imply different costs of providing public education, and that the difference in costs is responsible for whether an equalization reform leads to leveling up or leveling down. Jackson et al. (2014) show that equity-based reforms have no effect on total spending, while reforms that are adequacy-based increase

spending.<sup>5</sup>

I take an alternative approach to the state finance reform literature by characterizing school finance reforms by states adopting or removing a particular property from its existing state finance system. The crowd-out rates I measure here are important for a variety of reasons. The crowd-out rates are informative to address important policy questions like whether fiscal stimulus for the state government in the form of additional education contributions is an efficient way to raise education spending. This would certainly be the case in states with state finance systems whose properties indicate low levels of crowding out, or even crowding-in, but not in states where crowding-out rates are high.

### 3.3 Properties of state education finance systems

In this section, I discuss the different properties of state finance systems used in this analysis and describe the theoretical crowd-out rates implied by each one. The properties I use are an adaptation of those developed in Card and Payne (2002) and refined in Jackson et al. (2014). The state finance properties described below have very different implications on the ability and incentives for the local school districts to raise funds for education.

To illustrate the differences more clearly, consider the following equation:

$$\text{Total contribution/spending} = \frac{1}{n} (\text{Federal contribution} + \text{State contribution} + \text{Local base} \times \text{Local tax rate}) \quad (3.1)$$

Total contribution is the total amount of funds that were contributed toward education in the school district. Federal and state contributions are the portions was granted by the Federal and state governments respectively. Local contributions to education are determined as the product of the local tax rate and the local tax base, and is the portion of education funds that is paid for by residents of the school district itself.

The variable  $n$  is the number of students enrolled in the district, so the above equation represents the total amount of funds available to the local school district in per-pupil terms. To simplify the notation, let  $T$  be Total contribution,  $S$  be State contribution,  $B$  be the Local base, and  $t$  be the tax rate.

$$T = F + S + tB$$

The first property is a minimum foundation plan (MFP), which was used by 39 states

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<sup>5</sup>Equity-based reforms are aimed at reducing intrastate inequality in total spending. Adequacy-based reforms are those that are aimed at achieving a sufficient level of education funding in all districts, regardless of equity concerns.



in 2012. A minimum foundation plan acts to ensure a minimum spending level in every district in the state. States award the difference between education revenues raised by the district and the minimum spending level (“foundation level”) specified by the foundation plan. That is, if the state sets the foundation level at  $X$  per pupil, and school district A contributes  $Y$ , then the amount of state contributions for school district A is  $S_A = \max\{0, X - Y\}$ , and the amount of local contributions is  $t_A B_A = Y$ . Note that this implies that low-tax base districts, contribute less to education, and will receive more state funds. However, high-tax base districts are unchanged.

The crowd-out rate implied by MFP within a state is a direct consequence of the choice of  $X$  and  $Y$ . If states are increasing contributions, it must be that  $X - Y$  is increasing. The first possibility is that this is due to an increase in the foundation level (which affects all districts in the state). Consider that the foundation level increases from  $X$  to  $X'$ . Absent any other responses from the local district,

$$\begin{aligned}\Delta\text{Total contribution} &= \Delta\text{Federal contribution} + \Delta\text{State contribution} + \Delta\text{Local contribution} \\ &= \Delta\text{State contribution} \\ &= \max\{0, X' - Y\} - \max\{0, X - Y\} \\ &= 1\end{aligned}$$

Therefore, in a state with MFP, an increase in state spending solely due to an increase in the foundation level theoretically results in no crowding-out of state funds, because a \$1 increase in state funds increases total revenue by exactly \$1.

The second possibility is that the foundation level has not changed. Then any changes in local contributions induced by changes in the level of state contributions will be solely due to the crowd-out effect.

The second property is an equalization plan (EP),<sup>6</sup> which was used in 36 states in 2012. An equalization plan is generally aimed at eliminating spending differences due to different tax bases by providing state funds to school districts according the local tax base. For example, states can guarantee the same tax revenue to every district with the same tax rate. This can be implemented by allowing tax rates to generate the same revenue across all school districts regardless of the local base.

Consider two school districts where property values are different,  $A < B$ , but have the

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<sup>6</sup>Hoxby (2001) calls these power equalization plans.

same tax rate,  $t$ . Then following (3.1), we have

$$\begin{aligned} S_A + tA &= S_B + tB \\ S_A &= S_B + t(B - A) \end{aligned}$$

That is, low-tax base districts receive more state funds than high-tax base districts to make up for the lower tax base.

Note that the equalization plan formula does not specify how much states fund education, only that districts that perform the same tax effort receive the same amount from the state. Hence an increase in state funding does not necessarily imply increases or decreases in total education contributions.

The next property is a reward-for-effort plan (RE), where a state awards more state aid to school districts with higher tax rates. A common form of RE is matching grants. Note that RE requires that states give more funds to high-tax base districts, in contrast to EP, where low-tax base districts receive more funds.

The final property is a spending limit (SL), which imposes a maximum amount of total education spending. SL is not a property that is used on its own, but instead is one that is used in combination with another property. In a state that is using SL, increased state aid to a district will theoretically decrease education funds from all other sources one to one, if total spending is already at the maximum level specified by the education finance system. This type of finance system decreases inequality by limiting spending in wealthy districts to below the limit.

Jackson et al. (2014)'s categorization of state finance properties include two more properties that I exclude in my analysis. The first is flat revenue grants (FG), where states give a fixed amount of aid to each constituent district on a per-pupil basis. That is, all school districts receive some amount, regardless of the local tax base. This means that there is no variation in state contributions and no information to measure the crowd-out rate associated with FG. Finally, there is full state funding (FS), where the parent state takes on all the responsibility for funding public education. Because I am interested in studying the interaction between state and local contributions to education, I exclude FS in my analysis as it also provides no information.<sup>7</sup>

To see how these properties are used to characterize school finance reforms, consider California and the *Serrano* court case decision<sup>8</sup>, which legislated a reduction of within-state education spending inequalities by instituting a limit to education spending in all

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<sup>7</sup>As a robustness check, I perform the same analysis with FS and FG included. The estimates are not sensitive to this change.

<sup>8</sup>*Serrano v. Priest* II, 557 P.2d 929 (Cal. 1976). I use this case to illustrate my results in Section 3.6

California school districts. This reform would be characterized as going from the old state finance system (old SFS) to old SFS + spending limit. A list of Supreme Court rulings on state finance systems from 1967-2010 is available in Jackson et al. (2014).

Table 3.1 shows which states had education finance systems with particular properties as of 2012. Many states use a combination of two (or more) properties, and these states appear multiple times in the table. Figure 3.1 shows how the popularity of these different properties has changed over time. The number of states using a particular state finance property has remained flat between 2002 and 2012. In fact, between 2000 and 2010, 40 states do not change their education finance system.<sup>9</sup>

In order to get a sense of which state finance properties are likely to be used together, Table 3.2 lists the combinations of state finance properties in use for Fiscal Year 2012. Eleven states have state finance systems that can be described as having only one of the properties described earlier in this section. The modal combination of state finance properties is MFP and EP, with thirteen states using that combination. An additional 16 states use MFP and EP in combination with one or more of the other properties. RE is only used in combination with other state finance properties.

### 3.4 Data

In this section I discuss the data and the identification strategy in my analysis, and the underlying assumptions. The primary approach used in this analysis is an event study framework that utilizes changing state finance systems to identify the impact of the finance system on the crowding-out rates.

#### 3.4.1 Data and sample selection

School district data is primarily sourced from the National Center for Education (NCES) Common Core's Local Education Agency (School District) Universe Survey and the F-33 Local Education Agency (School District) Finance Survey, which together include information on all U.S. school district finances, including charter schools and other special purpose school districts. The Universe Survey data sets contain information on some school district student characteristics like enrollment, race distribution, and students with special needs. The F-33 data sets contain comprehensive information regarding school district budgets

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<sup>9</sup>This does not mean that the school finance systems in these states were unchallenged in this 11-year time span. One possibility is that any court cases brought in these states to reform the school finance system were either unsuccessful or the characteristics of the school finance systems were unchanged according to the five school finance properties.

and sources of education revenue, including the amount that is derived from property taxes, sales taxes, and so on.

My analysis focuses on the years 2002-2012. School districts in Montana, New Hampshire, and Vermont are excluded because these states report information for primary and secondary schools separately, even when these schools are in the same school district. The analysis also excludes Washington, D.C., which is not a U.S. state. To limit sensitivity of results to outliers, I drop the top and bottom 1% of school districts in terms of per-pupil total revenue. Many of these “outlier” school districts are outliers because of possible data entry error, where the budgets recorded are so large or so small to be unrealistic.

I also only consider school districts with more than 100 enrolled students, so that the data is less sensitive to year-on-year changes in district enrollment. This also allows me to exclude administrative school districts, who enroll no students but receive funds from the Federal and state governments. The final sample consists of 103,205 school district-year observations, covering 47 U.S. states.

### 3.4.2 Descriptive statistics

Descriptive sample statistics are reported in Table 3.3. Districts in states that use reward-to-effort plans are larger (high enrollment) than those in states that use state finance systems with other properties.

All fiscal variables are reported in per-pupil terms. Federal per-pupil contributions are roughly equal across all state finance properties. Local contributions are higher for districts in states that use MFP and EP, and lower for those in states that use SL and RE. Total expenditure generally reflects the patterns of local contributions. Most importantly for this analysis, state per-pupil contributions do not appear to be significantly different across state finance properties.

## 3.5 Estimation strategy

My empirical approach to estimate the effect of various school finance system properties on the crowding-out rates of state contributions on contributions from other sources relies on an event study framework, which requires that school finance reforms are plausibly random. That is, states that do not reform their finance systems in a particular year are good counterfactuals for states that do. The baseline estimation equation is the following:

$$NS_{sd,t} = \beta_0 + \sum_j \phi_{j,sd,t} [\beta_{1,j} + \beta_{2,j} SC_{sd,t}] + X'_{sd,t} \delta + \gamma_t + \varepsilon_{sd,t} \quad (3.2)$$

The dependent variable is the amount of per-pupil revenue from all sources other than the state government received by the school district  $sd$  at time  $t$ . The amount of per-pupil state aid received by the district is given by  $SC_{sd,t}$ .  $\phi_{j,sd,t}$  is an indicator for the education finance system used by the state which the school district belongs to having property  $j$ .

I also control for a set of time-varying district characteristics,  $X_{sd,t}$ . These characteristics include the share of black students, share of Hispanic students, poverty rate, and share of students that have special needs. I also include controls for the age distribution, specifically the share of school-age children living in the district. Finally, to account for contribution changes due to macroeconomic effects, I include a time trend. All fiscal variables are in 2012 dollars.

The coefficients of interest are the  $\beta_{2,j}$ 's. This coefficient is an estimate of the effect of a \$1 increase in state aid for a district on total revenue from non-state sources when the education finance system in the school district's state has property  $j$ . Because  $NS_{sd,t}$  is the sum of education spending from all non-state sources, a \$1 increase in state contributions increases contributions from other sources by  $\beta_{2,j}$ . This means that when  $\beta_{2,j}$  is 0 or greater, then there is no crowding-out by state funds. Instead, increased state contributions increases contributions from other sources. When  $\beta_{2,j}$  is less than 0, then there is crowding-out, and an additional dollar of state funding decreases contributions from all other sources.

The difference between the  $\beta_{2,j}$ 's indicates the relative crowding-out rates implied by each state finance system property. For states using finance systems with multiple properties, the net effect of an extra \$1 of state contributions on total funding is the sum of all relevant  $\beta_{2,j}$ 's. For example, Alabama used a school finance system with two properties in 2002: minimum foundation plan and equalization plan. Then if a district in Alabama received an extra \$1 of state funds, total education revenue from non-state sources in the district increases by

$$\beta_{2,MFP} + \beta_{2,EP}.$$

When  $\beta_{2,MFP} + \beta_{2,EP}$  is positive, then this is crowding-in of funds, so that additional state contributions increases total education revenue by  $\beta_{2,MFP} + \beta_{2,EP}$ . When  $\beta_{2,MFP} + \beta_{2,EP}$  is negative, then state funds are crowded out.

To the extent that the effect of having multiple state finance properties is not additive, I also perform the above estimation where I assign each state into a state finance system group according to the combination of properties of its state finance system. So, for example, because Alabama, Colorado, and Connecticut all have state finance systems characterized by a minimum foundation plan and an equalization plan, they are placed

into the same state finance system group. I then perform the following regression:

$$NS_{sd,t} = \beta_0 + \sum_j \phi_{k,sd,t} [\beta_{1,k} + \beta_{2,k} SC_{sd,t}] + X'_{sd,t} \delta + \gamma_t + \varepsilon_{sd,t} \quad (3.3)$$

Unlike equation (3.2), the index  $k$  here corresponds to a state finance group. Because all states are assigned into at least one group, the estimates of (3.3) will have one omitted group. The omitted group is the modal state finance group.<sup>10</sup> Comparisons between the estimates derived using (3.2) and (3.3) will be done by referring to this omitted group.

## 3.6 Results

### 3.6.1 A visual analysis

Figure 3.3 looks directly at the relationship between state education revenue and local education revenue in 2012 for each state finance property. For each property, districts are separated into deciles of per-pupil state revenue. State, local, and total education revenue is averaged within each decile. That is, consider the first panel of Figure 3.3. The red line traces out the relationship between mean state revenue (in the x-axis) and mean local district revenue (in the y-axis) for each decile of districts. Similarly, the blue line traces the relationship between mean state revenue and total revenue.

Several patterns are clear in this figure. First, the shape of the relationship between state revenue and other sources of revenue are similar across state finance properties. This is likely due to the high rate of overlap between the school finance properties (Figure 3.1).

Next, at low levels of state per-pupil contributions, districts contribute more locally to education, resulting in a high total revenues in these districts. As states increase their contributions, local contributions are crowded out, but at different rates in states with different state finance properties.

School districts that receive higher amounts of state education funds contribute less of their own funds on average. At a sufficiently high level of state contributions (at roughly the median state contribution level), local contributions reach a minimum level and are no longer crowded-out. This means that the decrease in local contributions are large for low levels of state contributions, but flat at high levels of state contributions. At that point total education revenues increase dollar for dollar with state contributions.

Critically for this analysis, there are differences across state finance properties. This is most obvious in levels: the top decile of school districts in states that use MFP or EP (in

<sup>10</sup>This is the group where the school finance system uses exactly two properties: minimum foundation plan and equalization plan. See Table 3.1 for Fiscal Year 2012.

the top panels of figure 3.3, respectively) receive much more state contributions than the top decile of districts in states the use SP or RE. Because the mean state contribution levels are roughly equal across state finance properties, this implies that the variance of state contributions is higher for districts in states that use MFP or EP.

Furthermore, the rate at which state contributions are crowded out is visually different across state finance properties. Districts in states that use a reward-for-effort plan (lower right panel) appear to crowd-out state contributions much faster than those in states that do not, as evidenced by a steeper red line at low levels of state contributions.

In the rest of this section, I empirically measure how much of the crowd-out rates are attributable to the state's choice of state finance systems. I describe how crowding-out rates differ across different state finance properties. I start with the estimation strategy described in (3.2) and (3.3), and report two sets of results. The first are based on cross-sectional data and show how the crowd-out rates have changed over time. The second use panel data and are estimates of the crowd-out rates using an event study framework.

### 3.6.2 Crowd-out rates over time

In this section, I analyze how crowd-out rates by state finance property have changed over time. I also show that the differences between state finance properties persist over the period of analysis, and are just not an artifact of chance.

Table 3.4 shows the cross-section estimates of  $\beta_{2,j}$  in (3.2). The lines through the estimate represent 95% confidence intervals around the estimate. From this graph, it is clear that crowd-out rates are very different between state finance properties even in the cross-section.

Districts in states that use a minimum foundation plan have crowd-in rates of about 40 cents per dollar prior to 2008, but after 2009, additional state education contributions crowd-out funds from all other sources by about 20 cents per dollar.

In states that use an equalization plan, I find evidence that additional state education contributions are crowded-out consistently over the time period of analysis, by about 25 cents for every additional dollar from the state government. However, the estimated crowd-out rates are not statistically significantly different from zero in 2009, 2011, and 2012.

In states that use reward-for-effort plans, I see evidence of crowding out of about 15 cents for every additional dollar of state education contributions. This estimated crowding-out rate is fairly consistent across the time period of analysis. Finally, districts in states that instituted spending limits, I see some evidence of crowding in, but for the most part funds from non-state sources are unaffected by additional state funds.

The Great Recession started at about the same time as (i) the shift from crowding-in to crowding out for MFP, and (ii) the loss of significance of the crowding-out estimates for EP. Because of this confounding factor, this phenomenon is difficult to interpret. This finding motivates event-study analysis using panel data, which allows me to account for large government-wide shifts by controlling for time trends. Furthermore, states adopting or removing properties from its existing state finance property aids in this identification.

### 3.6.3 Event study analysis

In this subsection, I analyze the crowd-out rates of state education contributions on contributions from all other sources and how these rates depend on properties of the education finance system used by the state. To aid in interpreting these estimates, consider the case of California, first mentioned in Section 3.3. *Serrano v. Priest* constituted of three California Supreme Court decisions in the 1970s. The court ruled that property tax rates and per pupil expenditures should be equalized across the state, and the difference in the revenue limits per pupil were mandated to be less than \$100. The California legislature responded to *Serrano* by passing a bill designed to equalize school revenues by putting a cap on per-pupil revenues in wealthy districts.

In the characterization of reforms in this paper, California moved from a state finance system with a minimum foundation plan (“MFP”) to a state finance system with a minimum foundation plan and spending limits (“MFP + SL”). There are two ways to think about this reform. The first is to think of California adding the property “SL”, and the impact of this addition on the crowd-out rate in the state is estimated in subsection 3.6.3.1. The second way is that California changed state finance property groups (MFP → MFP + SL), and the impact of this change on the crowd-out rate in the state is estimated in subsection 3.6.3.2.

#### 3.6.3.1 Crowd-out rates by school finance property

In this section, I present my results of the crowd-out rate of funding from all other sources by state contributions to education, when state finance properties are considered individually. These are estimates of  $\beta_{2,j}$ ’s where the  $j$  can be either “MFP”, “EP”, “RE”, or “SL.”

Table 3.4 contains these estimates. The dependent variable in these regressions is per-pupil contributions to education from all sources other than education. Each of the columns represents a separate regression, where I add, successively, state dummies, year dummies, and state  $\times$  year dummies. My preferred specification is in column 4.

I find the states whose education finance systems contain the MFP property have the



highest crowd-in rates, so that an additional dollar of state contributions to education cause local and Federal sources to increase their joint contribution by 14 cents. In states that have instituted spending limits, SL, the crowd-in rate is lower but still positive: 10 cents for every additional dollar of state contributions.

On the other hand, equalization plans and reward-for-effort plans result in state contributions crowding out education funds from all other sources. The property that implies the highest crowding-out rate is EP, equalization plans. A state with an education finance system that has the EP property has state contributions crowding out funds from all other sources by 19 cents for every dollar. Similarly, there is evidence that states which use a reward-for-effort plan, RE, see crowd-out rates of 12 cents for every additional dollar of state contributions.

Because some states use combinations of properties in their state finance system, it is important to think about what combinations of state finance properties imply regarding crowd-out rates. Because MFP and SL both result in crowding-in of funds, the crowd-in effect is reinforced by these two properties. Therefore, in states with both properties I observe crowding in of 24 cents for every additional dollar of state contributions. Similarly, EP and RE together imply a crowd-out rate of 31 cents for every additional dollar of state contributions. However, the combinations “MFP+SL” and “EP+RE” are only used by two states each.

The remaining states use combinations of properties where one implies a crowd-in of funds, while the other implies a crowding-out of funds. In these cases, the combination of properties result in a crowd-out rate that is not statistically significantly different from 0. In other words, for these combination of properties, the crowd-in and crowd-out effects offset each other, so that education revenue from all sources increases dollar for dollar with state contributions.

### **3.6.3.2 Crowd-out rates by property group**

The discussion in the previous subsection carries the assumption that the effect of the different state finance properties is additive. In this subsection, I relax this assumption and analyze how different combinations of state finance properties affect the crowd-out rate.

I present my results of the crowd-out rate of funding from all other sources by state contributions to education, when state finance systems are categorized into state finance property groups. These groups are defined according to their specific combination of state finance properties. For example, all states that use MFP and EP in their state finance system are grouped together into the “MFP + EP” group, and so on. A table of the different state finance groups, and the size of each is available in Table 3.2.

The estimation equation is (3.3), where the “k”s correspond to a state finance group. The dependent variable is per-pupil funds from non-state sources. The  $\beta_{2,k}$ ’s represent the impact of additional state contributions on the dependent variable when the school district is in a state in finance property group  $k$ . A state finance reform that changes the properties of the state’s education finance system would be represented by a state moving between state finance groups.

Table 3.5 contains these estimates. The dependent variable in these regressions is per-pupil contributions to education from all sources other than education. The omitted group is “MFP+EP,” which is also the modal state finance group. The estimates in table 3.5 should be interpreted as relative to this omitted group. Each of the columns represents a separate regression, where I add, successively, state dummies, year dummies, and state  $\times$  year dummies. My preferred specification is in column 4.

Beginning from the omitted group, “MFP + EP,” we can estimate what the effect of adding or removing a state finance property on the crowd-out rate. The estimate for “MFP + EP + RE” is -0.26, which means that adding the reward-for-effort property resulted in the crowding out of 26 cents of non-state funding for every additional dollar of state education contributions. Similarly, the coefficient estimate for the property group “MFP + EP + SL” is 0.211, so adding a spending limit resulted in a crowd-in rate of 21 cents for every additional dollar.

One can also work backwards to calculate crowd-out rates for adding the minimum foundation plan and equalization plan properties. The coefficient estimate for the group “MFP” is .267, which means that adding the EP property resulted in a crowding-out of 26 cents for every additional dollar of state contributions. Finally, the coefficient estimate for “EP” is -.402, so adding the MFP property resulted in a crowd-in rate of 40 cents for every additional dollar.

Although the estimates of crowd-out rates when adopting or removing a state finance property are not identical to the estimates in the previous subsection, this does not necessarily mean that the effect of these state finance properties are likely not to be additive. The estimates based on state finance groups are consistent in terms of the relative ordering of crowd-out/crowd-in rates.

### 3.7 Conclusion

In this paper, I analyze the effect of increased state contributions to public education on the amount of funds from all other sources received by the school district. I perform an event study analysis where state finance reforms are characterized by adopting or remov-

ing a state finance property. I calculate how the rate of crowding out of education funds from all other sources by state contributions depends on the properties of the state finance system adopted by the district's state.

This analysis helps address important policy questions debated as states move toward higher centralization of public education finance. As states increase their involvement in education funding, in order to fully understand the impact of increasing state contributions it is important to know how funding at the local district level is affected. This paper provides evidence that the minimum foundation plan property results in the lowest crowd-out rate—in fact, adoption of the MFP property implied that education contributions are crowded in by state funding. Similarly, a spending limit resulted in the crowding-in of funds. On the other hand, equalization plans and reward-for-effort plans resulted in the crowding out of education funds.

The findings of this paper are indicative that this alternative approach of characterizing state educational finance reforms as the adopting or removing of a state finance property is very promising. I use two different parametrizations of the impact of state finance properties on the effect of adding or removing a state finance property on the crowding-out rate of all other education funds by state contributions to education, and find that the different properties imply different things about the crowd-out rate of state contributions. However, more research is needed to identify the mechanism through which these effects occur.

### 3.8 Figures

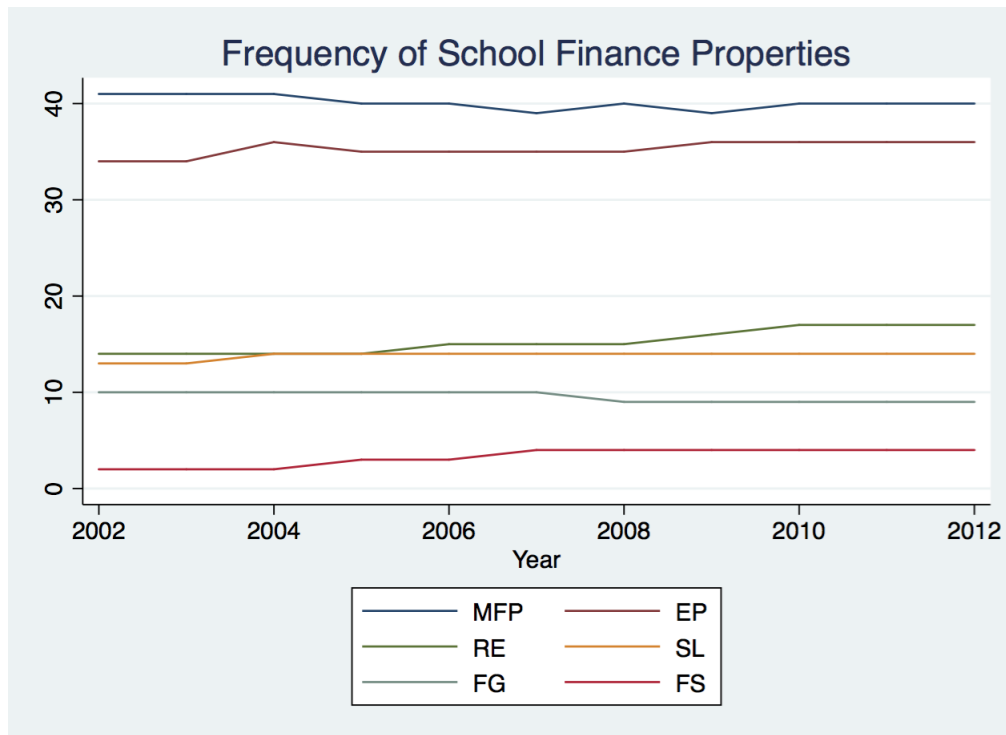


Figure 3.1: State finance properties over time

The figure above shows how many states use a particular state finance property between 2002 and 2012. Overall, the popularity of different state finance properties has remained fairly flat over the time period of interest.

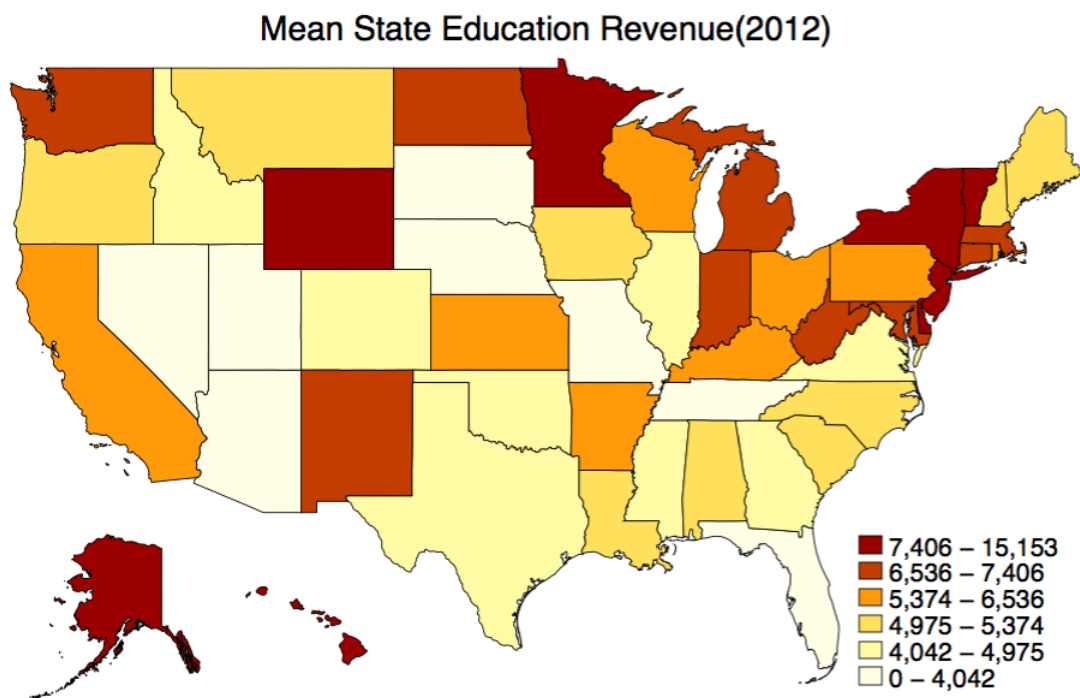


Figure 3.2: States and properties of the educational finance system, 2012

The figure above shows the mean level of state education revenue in each U.S. state for Fiscal Year 2012. State revenue levels are highly variable across states.

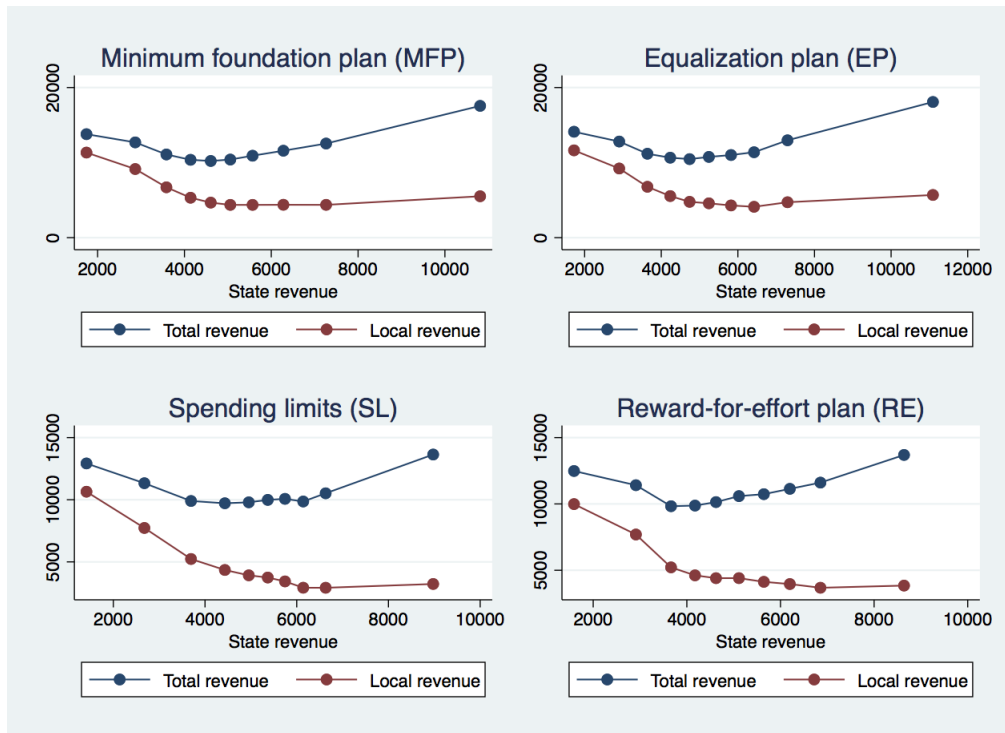


Figure 3.3: State revenues by source and state finance property

This figure shows the relationship between state education revenues, local revenues, and total education revenues, by state education finance property. The construction of this graph is described in section 3.4. All values are in per-pupil terms.

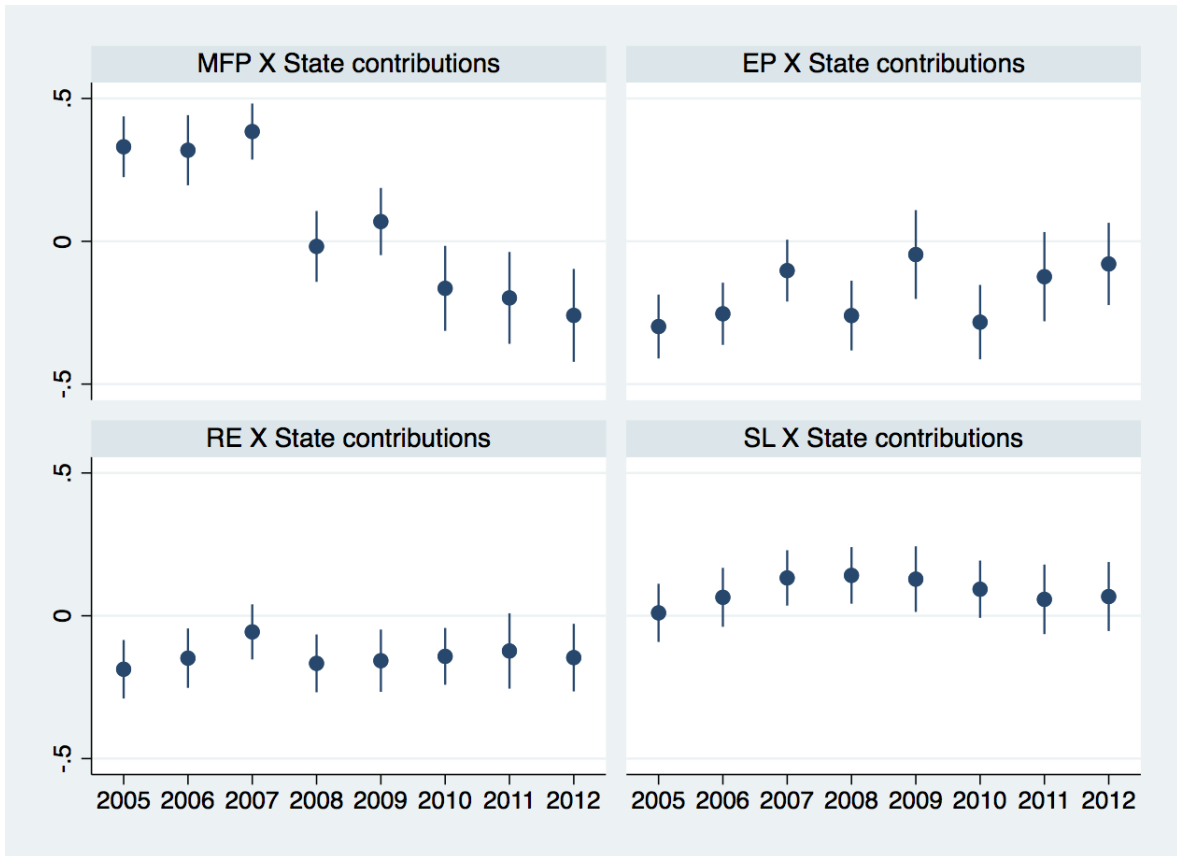


Figure 3.4: Crowd-out rates over time

The figure above shows how the coefficient  $\beta_{2,j}$  has changed over time. It is clear that the value of  $\beta_{2,j}$  are different when  $j$ , the state finance property, is different. Furthermore, these differences persist over the sample period.

### 3.9 Tables

Table 3.1: States and funding formula types, 2012

State Funding System Property	States
<b>Minimum Foundation Plan (MFP)</b>	AL, AK, AR , AZ, CA, CO, CT, FL, GA, IL, IN, KS, KY, LA, MN, MS, MT, MO, NE, NH, NJ, NM, NY, OH, OK, OR, PA, SC, SD, TN, TX, UT, VA, WY, WV
<b>Equalization Plan (EP)</b>	AL, AK, AR , AZ, CO, CT, DE, FL, GA, IL, IN, KS, LA, MD, ME, MI, MT, MO, NC, ND, NE, NH, NJ, NM, NY, OH, OK, OR, PA, RI, TX, UT, VA, WA, WI, WV
<b>Reward-for-effort (RE)</b>	AZ, FL, GA KS, KY, MD, ME, MO, MS, ND, PA, SC, TX, VA, MD, ME, WA, WI, WV
<b>Spending Limits (SL)</b>	AR, AZ, CA, HI, IA, ID, KS, MI, MT, NE, NH, OR, TX, VT, WA, WY

The table above contains the four most popular properties of state finance systems and the states that use them. With MFP, the state guarantees a minimum level of per-pupil spending in the districts.



Table 3.2: Frequency of combinations of state finance properties

	Number of States
EP	3
EP+RE	2
EP+RE+SL	1
EP+SL	1
FS	2
MFP	5
MFP+EP	13
MFP+EP+RE	7
MFP+EP+RE+SL	3
MFP+EP+SL	6
MFP+RE	4
MFP+SL	2
SL	1
Total	50

States often use education finance systems with multiple properties. The above is a frequency table of the different combinations of state finance properties used by U.S. states in 2012. MFP=minimum foundation plan, EP=equalization plan, SL=spending limit, RE=reward-for-effort plan. For completeness, the table about includes one more state finance property that I do not use in my analysis, as it is a characteristic of only one state's education finance system: FS=full state funding. This is the property of Hawaii's education finance system, which has a single school district.

Table 3.3: Summary statistics by state finance property

	(1) MFP	(2) EP	(3) RE	(4) SL
Enrollment	3904.6 (13376.8)	3667.8 (11638.5)	4692.6 (13949.6)	3902.5 (13864.3)
Federal contributions	1068.4 (990.7)	1027.2 (951.4)	1176.2 (970.1)	1085.7 (1044.9)
State contributions	5313.6 (2500.5)	5459.5 (2594.8)	5242.5 (2022.3)	5411.7 (2214.0)
Local contributions	5612.3 (4088.3)	5909.2 (4226.7)	4860.9 (3244.1)	4661.7 (3326.2)
Total expenditure	10786.6 (3611.6)	11212.1 (3718.3)	10194.4 (2600.3)	9925.6 (2573.2)
Observations	87358	81267	33906	37939

The above are summary statistics of the estimation sample. All fiscal variables are in per-pupil terms, and denominated in 2009 dollars. The state finance property appears uncorrelated with student enrollment, federal education contributions, or total education expenditure. Critically, the level of state contributions is fairly equal across these four properties of state finance systems, so that the crowd-out rates calculated in this paper have the same distributional base.

Table 3.4: Estimates of the crowd-out rate by state finance property

	(1)	(2)	(3)
	Non-state revenue	Non-state revenue	Non-state revenue
State contributions	0.286*** (0.0347)	0.323*** (0.0479)	0.285*** (0.0510)
MFP X State contributions	0.151*** (0.0346)	0.132*** (0.0375)	0.137*** (0.0402)
EP X State contributions	-0.170*** (0.0370)	-0.193*** (0.0418)	-0.190*** (0.0447)
RE X State contributions	-0.120*** (0.0362)	-0.121*** (0.0363)	-0.126** (0.0383)
SL X State contributions	0.103** (0.0384)	0.0922* (0.0388)	0.102* (0.0410)
Observations	103205	103205	103205
State dummies	X	X	
Year dummies		X	
State $\times$ year dummies			X

Standard errors in parentheses

\*  $p < 0.05$ , \*\*  $p < 0.01$ , \*\*\*  $p < 0.001$ 

This table contains the  $\beta_{2,j}$  estimates of equation (3.2), where the  $j$ 's correspond to the different state finance properties. All fiscal variables are in per-pupil terms, and denominated in 2009 dollars. The dependent variable is total education revenue from sources *other than* the state. Each column is a unique regression specification, with different combinations of fixed effects indicated by the bottom 3 rows of the table. My preferred specification is Column 4. I find that different state finance properties have different crowd-out rates. I calculate a crowd-in rate of 14 cents for MFP, which means that school districts in a state that adopted MFP will see higher total education spending by about \$1.14, with \$1 from the state and 14 cents from other sources. On the other extreme, I calculate a crowd-out rate of 19 cents for EP, so that school districts in a state will only spend an additional \$0.81 for every dollar of state funds received.

Table 3.5: Estimates of the crowd-out rate by property group

	(1)	(2)	(3)
	Non-state revenue	Non-state revenue	Non-state revenue
Per-pupil state contributions	0.299*** (0.00609)	0.294*** (0.00610)	0.270*** (0.00616)
EP	-0.371*** (0.0155)	-0.370*** (0.0155)	-0.402*** (0.0159)
EP + RE	-0.434*** (0.0217)	-0.426*** (0.0217)	-0.433*** (0.0220)
EP + SL	-0.388*** (0.0272)	-0.373*** (0.0272)	-0.412*** (0.0278)
EP + RE + SL	0.839*** (0.0269)	0.837*** (0.0268)	0.863*** (0.0268)
MFP	0.248*** (0.0193)	0.249*** (0.0193)	0.267*** (0.0196)
MFP + RE	0.332*** (0.0524)	0.317*** (0.0525)	0.307*** (0.0559)
MFP + SL	0.169*** (0.0144)	0.174*** (0.0144)	0.160*** (0.0148)
MFP + EP + RE	-0.211*** (0.0181)	-0.207*** (0.0181)	-0.261*** (0.0184)
MFP + EP + SL	0.198*** (0.0178)	0.195*** (0.0178)	0.211*** (0.0179)
MFP + EP + RE + SL	-0.219*** (0.0137)	-0.225*** (0.0137)	-0.241*** (0.0140)
Observations	103205	103205	103205
State dummies	X	X	
Year dummies		X	
State $\times$ year dummies			X

Standard errors in parentheses

\*  $p < 0.05$ , \*\*  $p < 0.01$ , \*\*\*  $p < 0.001$ 

This table contains the  $\beta_{2,j}$  estimates of equation (3.3), where the  $k$ 's correspond to the different state finance property groups. All fiscal variables are in per-pupil terms, and denominated in 2009 dollars. The dependent variable is total education revenue from sources *other than* the state. The interpretation of the estimates here are similar to that of Table 3.4. Unlike in Table 3.4, school districts are categorized into state finance property groups. Hence, all school districts which are in states that use MFP and EP are categorized into the “MFP + EP” group.

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